Soumyodeep Dey | Academic CV

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I have done my research work at the Department of Physics, Indian Institute of Technology Madras. My research work is based on nonlinear optical and thermo-optical behaviour under extreme light matter interaction due to high repetition rate ultrafast laser in *femtosecond* time scale as well as continuous wave lasers. My Ph.D. thesis title is *"Optical and thermal effects under continuous wave and femtosecond laser excitations"*.

Education

Academic Qualifications

- **Indian Institute of Technology, Madras** — **Chennai**
  Doctor of Philosophy, Nonlinear optics — *2016–2021 (5 years & 5 months)*
  CGPA:7.57/10
- **Indian Institute of Technology, Madras** — **Chennai**
  Master of Science, M.Sc. Physics — *2013–2015 (2 years)*
  CGPA:7.52/10
- **Ramakrishna Mission Residential College (Autonomous), Narendrapur** — **Kolkata**
  Bachelor of Science, Physics (Hons.) including Mathematics — *2010–2013 (3 years)*
  Marks: 60% (1st class)

Scholastic Achievements

- Recipient of **INSPIRE FELLOWSHIP** sponsored by **Department of Science and Technology (DST)**, Government of India *(2017-2021)*
- Recipient of **INSPIRE SCHOLARSHIP** sponsored by **Department of Science and Technology (DST)**, Government of India *(2010-2015)*
- Recipient of **Merit-cum-means award** for Class X Board Examination, Government of West Bengal *(2008-2010)*

Research Interest

Being a research scholar in a premier institute of India, IIT Madras, I was fortunate to have a well-established laboratory for my research work. While working with my research supervisor Prof. Prem B. Bisht, my initial interest grew towards the nonlinear light matter interactions under ultrafast laser excitation. This includes the self-phase modulation and spectral broadening of ultrafast laser pulses. These phenomena motivates me to generate supercontinuum laser sources and its applications in finding nonlinear parameters as a function of frequencies by a well-known technique of z-scan. For high repetition rate ultrafast pulses, alongside the optical effects, there exist significant thermal effects which leads to interesting phenomena while measuring nonlinear parameters of optical materials. I was able to investigate this thermal effects numerically by finite difference method and verified experimentally later. As the thermal effects due to continuous wave (CW) laser is a well-establish phenomena, I became motivated to investigate the pump-probe type geometry under such condition. As a result, a ring shaped beam has been generated similar to the Laguerre Gaussian vortex (LGV) beams. I have further investigated the phase profile of the thermally induced beam with the LGV beam and found distinctly different phase structure. This work was done in collaboration with Prof. Surendra

Singh from the University of Arkansas, USA. Working with Prof. Singh, motivates me towards the structure beam generation and its application in quantum optics as well as optical trapping experiments. Also during my PhD tenure I was able to be a part of the project to build Non-collinear Optical Parametric Amplifier (NOPA) and a Transient Absorption (TA) setup.

Notable Projects

- **Masters Project:** *'Spectral Phase Interferometry for Direct Electric field Reconstruction (SPIDER)'*. Duration: 1 year.

  Usually ultrafast pulses are represented in time domain but, also it can be represented by a broad spectral intensity as a function of frequency in spectral domain. In SPIDER, we use the concepts of chirping and sum frequency generation (SFG). An interferogram is obtained in frequency domain for the two SFG pulses. The Fourier transform of this interferogram is taken to take it back to the time domain from which the pulse information can be extracted.

- **Pre-doctoral Project:** *'Supercontinuum generation for transient absorption spectroscopy'* sponsored by Defence Research Development Organization (DRDO), Government of India.
  Duration: 1 year and 3 months.

  Supercontinuum (SC) generation with ultrafast pulses is a well-established topic for many years. Although the SC generation is very easy in presence of optical amplifier it is still challenging while working with oscillator with nJs pulses. A SC generation setup has been made with a solid core photonic crystal fibre (PCF) as a nonlinear medium. The combined effects of several nonlinear phenomena such as self-phase modulation (SPM), stimulated Raman scattering (SRS), optical soliton formation can lead to formation of new wavelengths. The generated SC will not only have a broad spectral range but also it will in ultrashort in time domain. This is because the pump laser is a fs oscillator.

- **Work Experience:** *'Development of Laser Measurement Devices'* sponsored by Laser Science Pvt. Ltd.
  Duration: Jan 2022 to Feb 2022 (2 months).

  During this period I have built a device which can measure femtosecond to picosecond laser pulses. This device is based upon the principle of sum frequency generation. A piezo and a linear actuator was used to control the movement of optical element for measuring the pulses. The complete electronics and programming of the micro-controller necessary for this were built in-house. A python based GUI was developed to control and analyses the data from a laptop via USB interface.

- **Post-doctoral Project:** *'Quantum Information, Communication and Computing'* at the department of ELECTRICAL ENGINEERING, IIT Madras
  From: Jun 2022.

  In this project I am building an optical setup for detecting spontaneous parametric down conversion (SPDC) from an optical meta-surface. This also involves numerical simulation of dielectric meta-surface for optimum generation of single photon by SPDC phenomena. I am also involved in developing a single photon counter from a photo-multiplier tube (PMT).

Experimental skills

- I was involved as a laser operator in the central laser facility of the institute. In this facility a femtosecond amplifier (Model: Coherent Astrella) was installed. This laser system can deliver output of $35\ fs$ @ $800\ nm$ and $1\ kHz$ of repetition rate.
- I have five years of experience of working with femtosecond oscillator (TISSA100, CDP) as a part of my PhD work.
- During my PhD work, I made few setups listed below.
  - **Autocorrelation setup :** A technique to measure ultrafast laser pulse durations in femtosecond time

domain.
- **Supercontinuum Generation Setup:** This setup can convert incoming monochromatic laser light in to a broad band light source ranging from $470\ nm$ to $1650\ nm$.
- **Mach-Zehnder Interferometer:** This setup has been made to characterize phase profile of structured beam including optical vortices.

While making these setups, I gained experiences about optical beam alignments, hardware interfacing (with LabVIEW, Labjack and Arduino), spatio-temporal matching of two ultrafast ($100\ fs$) pulses and phase matching by angle tuning. I have also hands-on experience on Laguerre Gaussian (LG) beam generation by spatial light modulator and its phase characterization by Mach-Zehnder interferometer.

- I am experienced working with optical chopper and lock-in amplifier to improve the signal to noise ratio.
- I have 2 years of experience in the undergraduate electronics laboratory as a teaching assistant.

Technical and Personal skills

- **Programming Languages:** Python, Arduino, TeX.
- **Industry Software Skills:** COMSOL, Multisim, LabVIEW, Origin Pro, Microsoft Power point and word.
- **Other:** Good soldering skills and making electronic circuits, Can write well organised and structured reports.

Interests and extra-curricular activity

I am a self-motivating person with great passion for every aspect of physics. I am also interested to learn new programming languages in my leisure time. So far, I became comfortable (and continuing) in many languages such as **C**, **Python**, **PhP**, **HTML & CSS**. As my primary hobby is web development, I am continuing learning few popular library like **jQuery** and **Flask** with python and **Django framework**. My secondary hobby includes SPICE simulations (with **NI Multisim**) of electronic circuits and testing them. I also enjoy 3D computer aided modelling with **Blender**.

References

- Up to 3 references available on request

Journal Publications

1. *Ring shaped fs supercontinuum with a thermally induced self-diffraction effect*, **Soumyodeep Dey**, Sugandh Sirohi, Surendra Singh and Prem Ballabh Bisht, **Applied Optics** Vol. 61, No. 32 (2022); doi.org/10.1364/AO.473714.
2. *Investigation of thermal nonlinearity due to nJ high repetition rate fs pulses on wrinkled graphene*, **Soumyodeep Dey**, Sudhakara Reddy Bongu, Vijay Kumar Sagar and Prem Ballabh Bisht, **Journal of the Optical Society of America B** Vol. 38, No. 6 (2021); doi.org/10.1364/JOSAB.420119.
3. *Study of a dark core beam generated by nonlinear thermo-optical effect*, **Soumyodeep Dey**, Sailaja Rallabandi, Surendra Singh and Prem Ballabh Bisht, **Optics & Laser Technology** 134, 106652 (2021); doi.org/10.1016/j.optlastec.2020.106652.
4. *Broad band nonlinear optical absorption measurements of the laser dye IR26 using white light continuum Z-scan*, **Soumyodeep Dey**, Sudhakara Reddy Bongu, and Prem Ballabh Bisht, **Journal of Applied Physics** 121, 113107 (2017); doi.org /10.1063/1.4978762.
5. *Single nanoparticle sensing and waveguide applications using photonic nanojet from an array of shaped*

microparticles, Tulika Agrawal, **Soumyodeep Dey** and Prem Ballabh Bisht, **Optics Communications**, 129110 (2022); doi.org/10.1016/j.optcom.2022.129110

6. *Numerical investigations on photonic nanojet coupled plasmonic system for photonic applications*, Tulika Agrawal, **Soumyodeep Dey**, Shubhayan Bhattacharya, Gurvinder Singh and Prem Ballabh Bisht, **Journal of Optics**, Vol 24, No.4 (2022); doi.org/10.1088/2040-8986/ac4d73
7. *Probing heteroatoms co-doped graphene quantum dots for energy transfer and 2-photon assisted applications*, Vijay Kumar Sagar, **Soumyodeep Dey**, Shubhayan Bhattacharya, Pooria Lesani, Yogambha Ramaswamy, Gurvinder Singh, Hala Zreiqat and Prem Ballabh Bisht, **Journal of Photochemistry and Photobiology A: Chemistry** 423, 113618 (2022); doi.org/10.1016/j.jphotochem.2021.113618.
8. *Optical characterization of graphene-f-o-phenylenediamine and charge transfer interaction with organic dye*, Vijay Kumar Sagar, Shubhayan Bhattacharya, **Soumyodeep Dey** and Prem Ballabh Bisht, **Carbon** 166, 15-25 (2020); doi.org /10.1016/j.carbon.2020.05.026.

Conference Proceedings

- *Generation of supercontinuum with nJ pulses in 450-1700nm range*, **Soumyodeep Dey**, Sudhakara Reddy Bongu, and Prem Ballabh Bisht, **13th International Conference on Fiber Optics and Photonics**, (2016); doi.org /10.1364/PHOTONICS.2016.Th3A.30.
- *Thermal and optical nonlinearity due to broadened femtosecond nJ pulses at high repetition rate*, **Soumyodeep Dey**, Sudhakara Reddy Bongu, and Prem Ballabh Bisht, **AIP Conference Proceedings**, 2244, 060006 (2020); doi.org /10.1063/5.0009060.

Conference Presentations

- *Zero dispersion wavelength shift in solid core photonic crystal fibre*, **S. Dey**, S. R. Bongu and P. B. Bisht in **National Laser Symposium (NLS-26)**, BARC, Mumbai, Dec-19-24, (2017) *(Poster Presentation)*.
- *Supercontinuum generation in photonic crystal fibre on pumping with fs laser pulses*, **S. Dey**, S. R. Bongu, P. B. Bisht in **International Conference on Advancement in Science and Technology (ICAST-2018)**, Visva-Bharati, Santiniketan, India, September 3-4, (2018) *(Poster Presentation)*.
- *Effects of High Repetition Rate Ultrafast Laser Pulses on Spatial Self-phase Modulation*, S.Dey and P. B. Bisht, in **National Laser Symposium (NLS-29)**, Shri Vaishnav Vidyapeeth Vishwavidyalaya (SVVV), Indore, Feb-12-15, (2021) *(Oral Presentation)*.

Workshop Attended

- Participated in the **Science and Technology Exhibition 2011** organized by the **IEEE Calcutta University Student Branch**, Calcutta University, Kolkata, West Bengal, India.
- Participated in a **UGC sponsored National Seminar on Quantum Mechanics: Inception, Evolution and Future** organized by **Department of Physics, Narasinha Dutta College, Howrah** in collaboration with **Seth Anandram Jaipuria College**, Kolkata in a three-day workshop.
- Participated in **West Bengal Science & Technology Congress** in a two-day workshop organized by **Ramakrishna Mission Residential College (Autonomous), Narendrapur** in collaboration with **West Bengal Science & Technology Department, Government of West Bengal.**