Manik Pradhan

Associate Professor
CBMS
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Guidance of Students/Post-Docs/Scientists

a) Ph.D. Students

1. Sanchi Maithani; Cavity Ring-down Spectroscopy and Evanescent Wave; Thesis submitted
2. Mithun Pal; Quantum Cascade Laser Spectroscopy; Awarded
3. Akash Das; Quantum weak measurements in 2D materials; Under progress
4. Biswajit Panda; High-resolution molecular spectroscopy; Under progress
5. Ardhendu Pal; Cavity ring-down spectroscopy; Under progress
6. Vishal Agarwal; Nanomaterials and Spectroscopy; Under progress; Manik Pradhan (Co-supervisor)
7. Soumen Mandal; Optical beam shifts; Under progress
8. Sudip Mandal; Surface Plasmon Resonance; Under progress

b) Post-Docs

1. Arpan Maiti; Nano Materials and surface plasmon resonance
2. Arun Bera; Gas sensing and nano materials
3. Jayeta Banerjee; Nano materials and surface plasmon resonance

c) External Project Students / Summer Training

1. Sayani Bhattacharya; Breath Analysis and medical diagnosis; TRC Project Student (SNBNCBS)
2. Saikat Ghosh; Nano Materials and isotope analysis; SERB Project Student
3. Debatri Ghosh; Breath analysis and medical diagnosis; TRC Project Assistant (SNBNCBS)

Teaching

1. Spring semester; Project Research III (PHY 401); Title: Quantum weak measurements and applications to material science; Integrated PhD; 1 student
2. Spring semester; Project Research III (PHY 401); Title: Surface plasmon resonance and its applications to condensed matter physics; Integrated PhD; 1 student
3. Spring semester; Methods in Experimental Physics (PHY 391) Shared; Integrated PhD; 13 students
4. Spring semester; Summer Project Research I (PHY 292); Title: Laser Spectroscopy: techniques and applications in environmental and biomedical sciences; Integrated PhD; 1 student
5. Autumn semester; Project Research II (PHY 304); Title: Laser Spectroscopy: techniques and applications in environmental and biomedical sciences; Integrated PhD; 1 student

Publications

a) In journals

1. Abhijit Maity, Sanchi Maithani, Ardhendu Pal and **Manik Pradhan**, *High-resolution spectroscopic probing of ortho and para nuclear-spin isomers of*

heavy water in the gas phase, Chemical Physics, 541, 111041, 2021

2. Abhijit Maity, Sanchi Maithani, and **Manik Pradhan**, *Cavity Ring-Down Spectroscopy: Recent Technological Advancements, Techniques, and Applications*, Analytical Chemistry, 93, 388-416, 2021
3. Akash Das and **Manik Pradhan**, *Wavelength and chemical potential dependence of optical beam shifts in graphene*, Journal of Modern Optics, 68, 146 – 152, 2021
4. Akash Das and **Manik Pradhan**, *Quantum weak measurement of Goos-Hänchen shift in monolayer* MoS_2, Journal of the Optical Society of America B, 38, 387 – 391, 2021
5. Puspendu Barik and **Manik Pradhan**, *Plasmonic luminescent solar concentrator*, Solar Energy, 216, 61 – 74, 2021
6. Akash Das and **Manik Pradhan**, *Investigation of the optical beam shifts for monolayer* MoS_2 *using polarimetric technique*, Journal of Optics, 22, 105004, 2020
7. Sanchi Maithani and **Manik Pradhan**, *Cavity ring-down spectroscopy and its applications to environmental, chemical and biomedical systems*, Journal of Chemical Sciences, 132, 114, 2020
8. Akash Das and **Manik Pradhan**, *Quantum weak measurement of Goos–Hänchen effect of light in total internal reflection using a Gaussian-mode laser beam*, Laser Physics Letters, 17, 066001, 2020

b) Conference proceedings / Reports / Monographs / Books

1. Dheeraj Singh, Manik Pradhan and Arnulf Materny, "Modern Techniques of Spectroscopy: Basics, Instrumentation and Applications": Springer Nature (ISSN: 2363-5096), 2021
2. Abhijit Maity, Mithun Pal and Manik Pradhan, "Cavity Ring-Down Spectroscopy": "Modern Techniques of Spectroscopy: Progress in Optical Science and Photonics, vol 13": Springer Nature (ISBN: 978-981-33-6083-9), 2021
3. Mithun Pal and Manik Pradhan, "Quantum Cascade Laser Spectroscopy": "Modern Techniques of Spectroscopy: Progress in Optical Science and Photonics, vol 13": Springer Nature (ISBN: 978-981-33-6083-9), 2021
4. Mithun Pal and Manik Pradhan, "Exhaled Breath CH_4 and H_2S Sensing using Mid-IR Quantum Cascade Laser (QCL)": Progress in Optomechatronics: Springer Nature (ISBN: 978-981-15-6467-3), 2020
5. Abhijit Maity, Sanchi Maithani and Manik Pradhan, "Cavity Ring-Down Spectroscopy: Recent Technological Advances and Applications": "Molecular and Laser Spectroscopy: Advances and Applications Volume 2, Elsevier, (ISBN: 978-0-12-818870-5), 2020

Talks / Seminars Delivered in reputed conference / institutions

1. Structure and Dynamics in Biology, Chemistry and Material Science; Nov 16, 2020; IIT Roorkee; 16-20 November, 2020

Administrative duties

1. Member of SCOLP Committee
2. Member of Works Committee
3. Member of Reservation Cell Committee
4. Member in various Interview and Thesis Committee

Patents Taken and Process Developed with Details

1. "A system and kit for non-invasive detection of peptic ulcer disease, non-ulcerous dyspepsia and Helicobacter pylori infection", FER submitted on 25/02/2021; E-91/872/2021/KOL; Applied
2. "A Gas-sensing system for selective detection of NO gas and a method for fabricating the same", FER submitted on 19/03/2021; E-91/1284/2021/KOL; Applied
3. "Dioxo vanadium (V) complex as carbonic anhydrase inhibitor", Date of Granting: 16/06/2020; 338829; Granted

Awards, Recognitions

1. Fellow of Royal Society of Chemistry (FRSC)
2. Fellow of Linnean Society of London (FLS)
3. Early Career Board Member of Analytical Chemistry of American Chemical Society (ACS)
4. Editorial Board Member of Chemical Physics Impact (Elsevier)

Membership of Learned Societies

1. Americal Chemical Society (ACS)
2. Royal Society of Chemistry (RSC)
3. Chemical Research Society of India (CRSI)
4. Indian Physics Association (IPA)
5. Indian Laser Association (ILA)
6. Indian Society of Chemists and Biologists (ISCB)
7. Research Society for the Study of Diabetes in India (RSSDI)

Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Understanding of growth of vertically aligned nanowires or nanotubes of binary oxides and physics of isotopic fractionation of gases by them; DST; 2017-2021; Co-PI

Areas of Research

Laser Spectroscopy, High-resolution Molecular Spectroscopy, Applications of Laser Spectroscopy in Environmental, Biomedical and Material Sciences

1. Cavity Ring-Down Spectroscopic Detection of Nuclear Spin Isomers of Heavy Water in the Gas Phase:

Doubly deuterated water (D_2O) exhibits two distinct nuclear spin-isomers, ortho and para, which have not much been studied and there is hardly any information about the spin-exchange processes of D_2O. Here, we investigated the nuclear-spin quantum states of D_2O in gas phase by evaluating the ortho-to-para ratio (OPR) using high-resolution cavity ring-down spectroscopy coupled with quantum cascade laser in the mid-IR spectral region at 7.8m. We experimentally achieved an OPR of (1.950.16):1 for D_2O spin-isomers in the isolated gaseous phase. We further analyzed the OPR of the residual D_2O in a 1:1 mixture of D_2O and H_2O, and observed indications of potential alteration of thermodynamic probability of ortho and para nuclear-spin states of D_2O associated with the D-H exchange reaction in the system. Our findings pave the way to probe directly the spin behaviour of D_2O molecules in the gas phase and thus fostering exploration of spin-dependent chemistry in a wide range of chemical and biological systems.

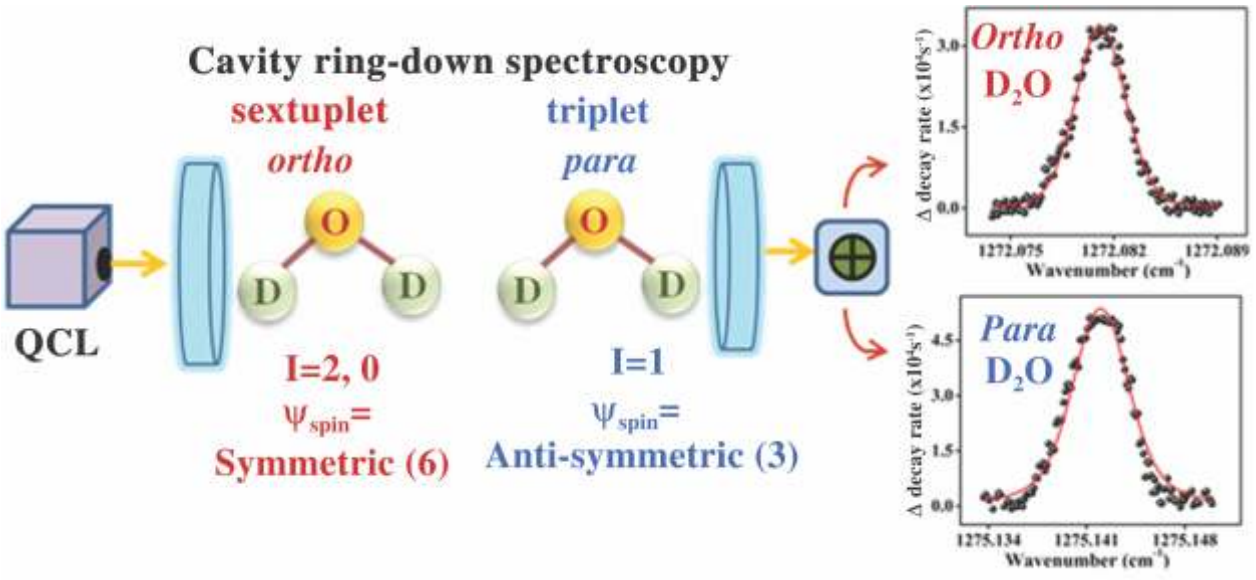

Figure 1: Optical detection of nuclear-spin isomers of D_2O

2. Development of Quantum Weak Measurement Technique for Optical Beam Shifts Measurements:

We have developed the quantum weak measurement (QWM) technique for the demonstration of the Goos-Hänchen (GH) shift of light in total internal reflection (TIR) condition for a Gaussian mode laser beam of 633nm passing through an air-glass interface. The QWM technique has been exploited as a weak value amplification scheme to observe the amplified optical GH shift. The amplification of the GH shift depends on the angular deviation from the exact orthogonal position required for weak measurement. We subsequently investigated in detail the profiles of the beam pattern and their horizontal and vertical shifts. We have also presented that the beam shift values obtained experimentally agree well with the theoretical results for a specific choice of angle of deviation from the orthogonal condition of weak measurement. Our results clearly demonstrate the advantages of the QWM technique for amplifying and detecting tiny optical beam shift effects and may provide important applications in precision metrology.

Plan of Future Work Including Project

1. Development of Broadband Cavity Enhanced Absorption Spectroscopy (BBCEAS) technique for trace molecule detection.
2. Exploration of Spin-chemistry in gas phase molecules
3. Investigation of optical beam shifts in various 2D materials using quantum weak measurement.

Any other Relevant Information including social impact of research

1. "Pyro-Breath" technology has transferred to a startup company for commercialization. The device diagnoses H. pylori bacterial infection in stomach and various gastric disorders by human exhaled breath analysis without going for painful endoscopic based biopsy tests.

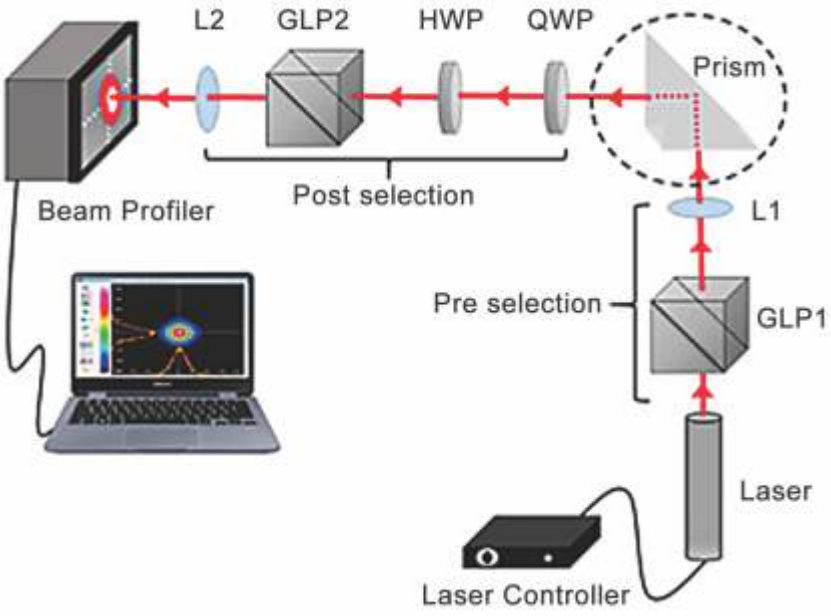

Figure 2. Experimental setup for Quantum Weak Measurement