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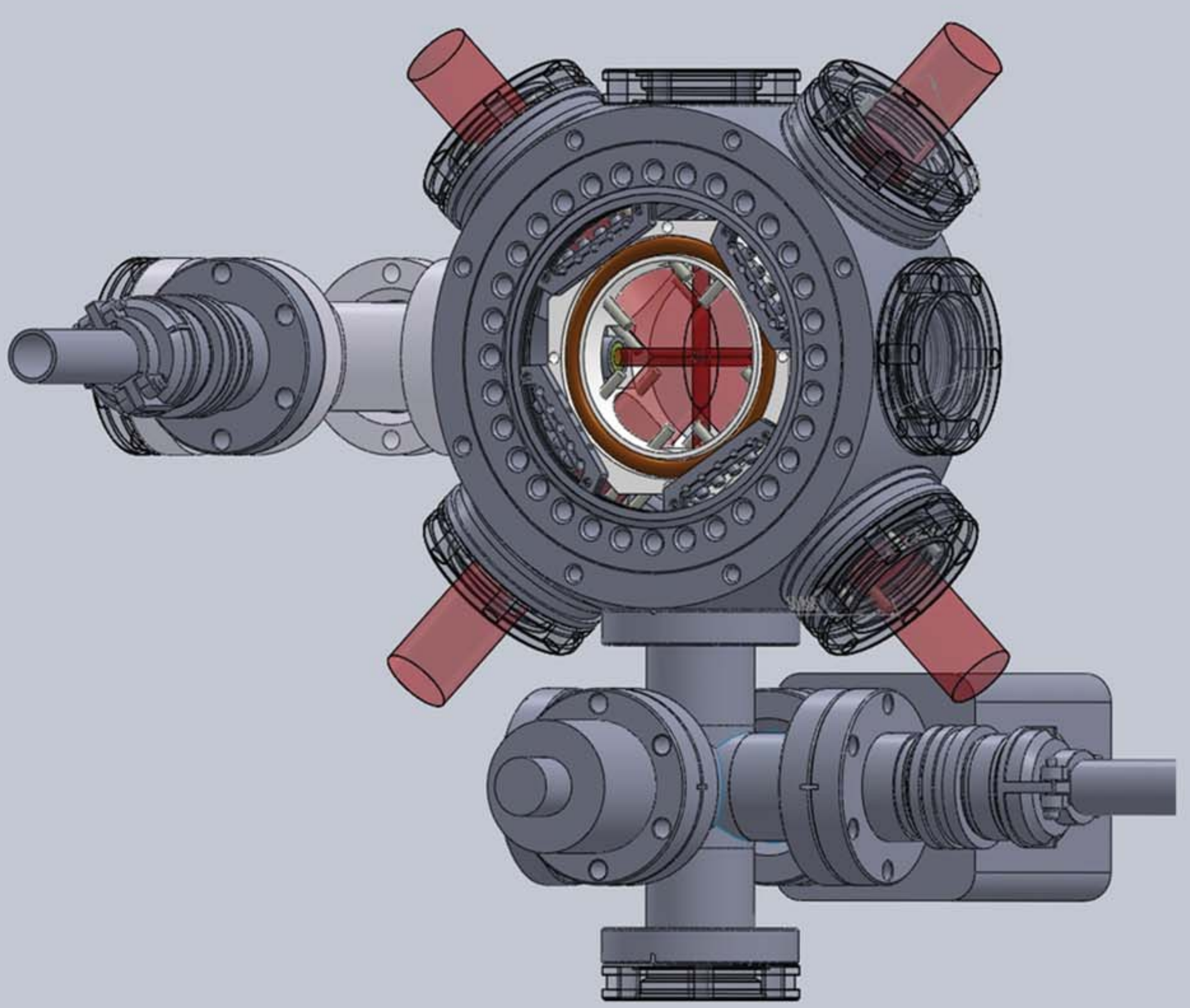
R&D Newsletter

INDIAN INSTITUTE OF TECHNOLOGY KANPUR



A simulated structure of the double cavity-quantum-electrodynamic (QED) setup proposed to be build at IIT Kanpur Page 3

Inauguration of *Bio Incubator at IITK*

The Bio incubator at SIDBI Innovation and Incubation Center (SIIC), IIT Kanpur was inaugurated on 4th March, 2016 by Dr. Renu Swarup, Managing Director, BIRAC in the presence of Professor Indranil Manna, Director, IIT Kanpur. Bio-incubator@iitk was established by BIRAC, under the Bio-Incubator Support Scheme (BISS). It is a huge fillip for budding entrepreneurs working in the areas of biotechnology, biopharma and biomedical devices.

The facility has complete infrastructure for large scale protein production and purification for pharmaceutical purposes. At present there are nine companies getting incubated at Bio-incubator@iitk. Some of the current incubatee companies have availed funding under BIRAC schemes and are involved in the domains of drug discovery and smart material development for the purpose of implantation. To support commercialization of ready implant fabrication, the incubator has a high-end class 10000 grade Clean room facility which is unique in the incubation space.

Students' Research

Pushpak, the SAE Aero Design team of IIT Kanpur under the Science and Technology Council recently participated in SAE Aero Design East 2016, Dallas, Texas. The four member team secured overall second runner-up position in both the Micro Class and in the payload fraction category. Several international teams participated in this design and optimization based aviation competition.

Industry Connect Talk Series

In the Industry Connect Talk Series, organized by the Industrial Collaboration Advisory Group (ICAG), speakers from the industry are invited to present their company's research areas of interest to explore possibilities of collaboration with researchers at IIT Kanpur.

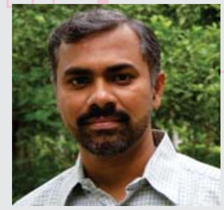
A team from Mitsubishi comprising Mr. Hikaru Tashiro (Team Head), Mr. Yuichi Koga, Mr. Naoyuki Fujiwara and Mr. Rohit Arora, presented on 18th March, 2016, an overview of the research and innovation at Mitsubishi Heavy Industries Ltd. Founded in 1884, Mitsubishi Heavy Industries Ltd. sought to pioneer new approaches in manufacturing and contributed to the development of societies. Their wide areas of research interests for possible collaborations include technical issues related to the field of Materials Technology, Manufacturing Technology, Chemical & BioTechnology, Structure & Strength Technology, Vibration Technology, Tribology Technology, Fluid Dynamics Technology, Combustion, Heat Transfer Technology, Instrumentation & Electronic, Application Technology, and System Control Technology.

On 29th March, 2016, Dr. Pushpendra Kumar from Oil and Natural Gas Corporation (ONGC) delivered a talk on the technological challenges for commercialization of gas hydrates. Dr. Kumar is the General Manager and Head-Unconventional Research Group at Keshav Dev Malviya Institute of Petroleum Exploration (KDMPE), ONGC, Dehradun India. He is leading the Indian National Gas Hydrate Program on behalf of Ministry of Petroleum and Natural Gas, Govt. of India for the next phase, i.e, gas hydrate pilot production testing in KG deep offshore area NGHP – 3.

MOU signed with ONGC

An MOU was signed between IIT Kanpur and ONGC on 29th March, 2016. The MOU was signed by Prof. Amalendu Chandra, DORD, IIT Kanpur and Dr. Devendra Narayan Singh, Executive Director, KDMIPE, ONGC, Dehradun India.

A Triggered Source of Single Photons and Photon Pairs



PI: Prof. Saikat Ghosh, Physics
Co-PI: Prof. Harshawardhan Wanare, Physics
Sponsor: Science and Engineering Research Board

The project proposes to develop a high-brightness triggered source of single photons and photon pairs, using laser cooled ensemble of Rubidium atoms coupled to two optical cavities. A cascaded four-wave mixing scheme is proposed for optically pumped cold atoms to generate on-demand photons together with a fast multi-photon counting system to characterize the source. The key novelty of the project is implementation of a double-cavity system integrated in conjunction with the atomic ensemble to enable operation at extremely low light levels. The two coupled optical cavities will be used to realize an "on-demand" bi-photon source, a still outstanding problem in the field. The high brightness photon source, once developed will be used, in conjunction with a confocal microscope to couple triggered photons to single nano-particles, towards creating an interface between cold atoms and solid-state materials.

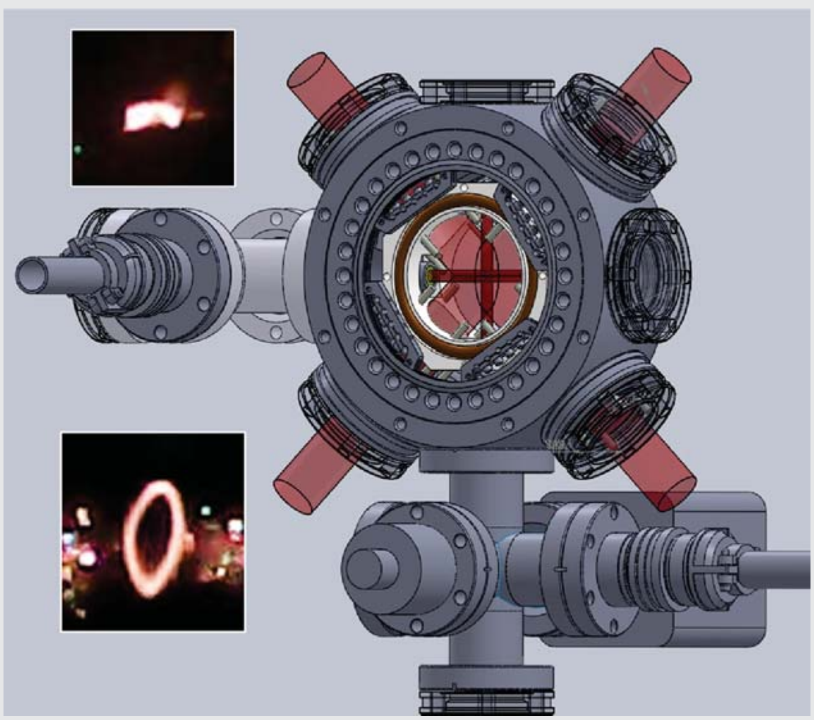


Figure : A simulated structure of the double cavity- quantum-electrodynamic (QED) setup that will be built at IITKanpur to host the experiment. The blue cross in the middle shows the two optical cavity modes.
Inset: A real-time picture of a cloud of a million Rubidium atoms, at a temperature of 100 micro-Kelvin, laser cooled and trapped in the laboratory at IITKanpur. These cold atoms will be used as the source of correlated and triggered photon pairs.

Off-Design Engine Modeling of Aero-Engines

PI: Prof. Ashoke De, Aerospace Engineering
Co-PI: Prof. Abhijit Kushari, Aerospace Engineering
Sponsor: DRDO

The life prediction and extension of failure critical components in various engines is essential to reduce maintenance cost and improve asset availability and readiness. In this context, predictions of flow parameters over these critical components under actual usage conditions will be important for estimating the damage accumulation with physics based modeling approaches.

The proposed project primarily aims to develop a methodology to predict engine performance under off-design operating conditions and to compute flow parameters at different components (like compressor, combustor and turbine) for different aero-engines operating under the IAF. Different strategies have to be developed based on the engine configurations like number of compressor and turbine modules with after-burner ON and OFF conditions. Both steady state and transient analysis has to be carried out. This is solely going to be thermodynamic analysis based off-design engine modelling to estimate performance parameters for two engines namely single shaft turboprop engine and twin spool turbofan engine.

Role of Neural Oscillations in the Processing of Behaviorally Salient Odors by the Mosquito Brain

PI: Prof. Nitin Gupta, Biological Sciences & Bioengineering
Sponsor: Department of Biotechnology

Mosquitoes show innate attraction to human smell, which is one of the important cues used by mosquitoes to find humans. The scientific community has begun to identify the neurons on the mosquito sensory organs that are important for mediating attraction to human odors, or aversion to common repellents such as DEET. But the mechanisms inside the mosquito brain that connect the activity of the sensory neurons to their behavior are not known. Neural oscillations, which reflect the synchronized activity of large sets of neurons and are important for discriminating odors, could play an important role in determining attraction and repulsion to odors. This project proposes to develop techniques for observing odor-induced oscillations in mosquitoes, and test their role in coding of behaviorally important odors.

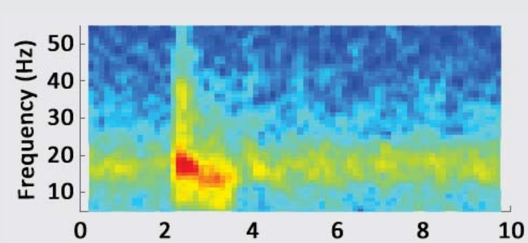


Figure: The spectrogram indicates the presence of 15-20 Hz oscillations in neural activity during odor sensing.

Stereoisomers of New Dipicolylamine Complexes from Multi-Component One-Pot Reactions: Isolation and Post Synthetic Modification, Transmetallation and Bioinspired Hydrogen Production Catalysis

PI: Prof. Raja Angamuthu, Chemistry

Sponsor: Science and Engineering Research Board

The maiden effort of this project is to focus on the synthesis of new family of tridentate ligands comprising 2,2'-dipicolylamine moiety and its metal complexes. To synthesize these new ligands, we will take advantage of a newly designed four component dynamic covalent assembly comprised of pyridine-2-carboxaldehyde, N-substituted ethylenediamine, aliphatic primary alcohol and a transition metal ion. Test reactions have been carried out and found to support the proposed one-pot multi-component synthetic route. Complexes proposed are inaccessible by normal routes and demand tedious multistep synthetic process. This new synthetic route may allow us to synthesize catalysts suitable for reactions which are industrially and environmentally significant such as hydrogen production.

Development of Novel Visible Light Promoted Transformation

PI: Prof. Anand Singh, Chemistry

Sponsor: Science and Engineering Research Board

The development of new, efficient, and environmentally sustainable chemical transformations is the overarching goal of modern organic chemistry research. This proposal outlines plans for the development of novel carbon-carbon bond forming reactions employing visible light photocatalysis. The central tenet of the hypotheses presented herein is the exploration of unconventional radical pathways as a means to generate molecular diversity and complexity, ultimately culminating in the development of a new repertoire of catalytic reactions. The emphasis is on the direct synthesis of structural building blocks that are not easily accessible via classical methods. The first part of the project focuses on establishing reactivity patterns of relatively unexplored synthetic precursors (geminal di-halo compounds) that ultimately lead to the generation of unsymmetrical diaryacetates that are not easy to access via known methods. The scope of the method will be extended to more complex halogenated starting materials in order to access natural product architectures in a concise and efficient manner. The second part of the project includes the development of catalytic, enantioselective reactions either employing chiral photocatalysts or a dual catalysis manifold wherein the chirality is imparted via a separate, second catalyst. The project also plans to develop/explore catalysts that undergo two-photon absorption thereby enabling the activation of stronger bonds than that was possible earlier. This will allow the application of easily available precursors such as chlorinated aryls as opposed to their diazo derivatives, and also provide increased scope in the alkyl halide realm. Collectively, these reactions will result in tertiary stereocenters with the possibility of contiguous stereocenter generation, and also provide access to products with all-carbon quaternary stereocenter. Application of these reactions and concepts to the synthesis of scaffolds relevant to natural product synthesis will be demonstrated. Overall, this proposal aims to harness visible light to establish new reactivity patterns, explore and develop new enantioselective photoredox chemistry, and ultimately provide synthetic routes to functionality that were difficult to obtain using existing methods.


Modeling and Simulation of Methane Extraction from Gas Hydrates via Simultaneous Depressurization and CO_2 Injection

PI: Prof. M.K. Das, Mechanical Engineering
Co-PI: Prof. K. Muralidhar, Mechanical Engineering
Sponsor: Oil Industry Development Board

Gas hydrates refer to a class of solid crystalline compounds where guest gas molecules are encaged in a solid H_2O lattice. Of commonly occurring gas hydrates, methane hydrate, present in the marine sediments, is now identified as a potential source of hydrocarbon fuel. The global storage of methane, in the hydrate form, exceeds all other known hydrocarbon reserves, and may sustain the global energy demand for the next few centuries. Present project deals with the development of sustainable, cost-effective methodologies for methane recovery from marine sediments. In this regard, depressurization is proposed as the preferred technique for methane recovery. Major challenge of any such recovery technique is to maintain the structural integrity of the fragile marine-ecosystem. To ensure the structural stability, injection of CO_2 in the hydrate-bearing sediment is considered. Sequestration of CO_2 also enhances the methane recovery rate and helps us to combat the anthropogenic CO_2 emission. Present project primarily relies on the model development and high-performance computing of the multiphase-multiphysics transport phenomena at high-pressure, low-temperature environment. The project will procure large computer clusters enhancing the current computing capabilities of the institute. The project will also support several graduate students inspiring our sustained effort of human resource development.



Microstructural and Tribological Characterization of Stainless Steel 316L obtained by Modulated Machining

PI: Prof. Shashank Shekhar, Materials Science & Engineering
Co-PI: Prof. Gouthama, Materials Science & Engineering
Prof. J. Ramkumar, Mechanical Engineering
Collaborators: Shri N. L. Soni, BARC
Sponsor: Department of Atomic Energy

It is known that presence of refined microstructure on the surface of a material can lead to substantial improvements in mechanical as well as functional properties. Moreover, textured surface layer have been shown to endow materials with improved wear resistance and other multifunctional characteristics like electrochemical and biological responses. Enhanced corrosion resistance and increased sub-micron scale features on the surface have significant implications for nuclear industry.

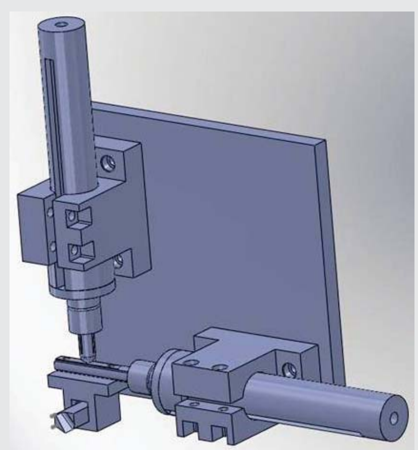


Figure: Two-axis modulation fixture along with cutting tool

One of the major goals of this project is to develop a two-axis modulation fixture which will be placed on the tool-post of a lathe-machine. This modulation fixture would be used to generate two-dimensional sub-micron features on surface of steel substrate along with grain refinement in the sub-surface layer. Microstructural and tribological characteristics of these machined samples will be studied as a function of deformation parameters and modulation parameters.

Central Sector Scheme for MOOC Compliant E-Content Creation (NPTEL Phase IV)

PI: Prof. Satyaki Roy, Design Program

Sponsor: MHRD

Over the past ten years, the National Programme on Technology Enabled Learning (NPTEL) has been successful in creating the largest online repository in the world of courses in engineering, basic sciences and selected humanities and social sciences subjects and maintaining the popular online web portal http://nptel.ac.in

Cognizant of the rapid advances and changes in the area of online , NPTEL Phase IV has proposed new activities which is in tune with the recently initiated scheme of the Ministry of Human Resource Development (MHRD) called the Central Sector Scheme (CSS) for MOOC-compliant e-content creation. The goal of the scheme is to produce e-content that can be offered as Massive Open Online Courses (MOOCs) at different levels of education. The courses are aligned with the semester system with a predefined start and end date for the courses. The courses consist of video lectures, lecture transcripts, assignments, quizzes and active discussion forum. At the end of the course, enrolled students have the option of registering for a proctored examination. Students who register for the examination and meet the eligibility criteria receive an NPTEL certificate. CSS for MOOC compliant e-content creation NPTEL IV is administered through a national committee known as the Programme Implementation Committee. Dr.Andrew Thangaraj and Dr.Prathap Haridoss (IIT Madras), Dr.Kushal Sen (IIT Delhi) and Dr.Satyaki Roy (IIT Kanpur) are the national coordinators responsible for implementation of the project. Given its experience, expertise, and success of NPTEL, Central Sector Scheme for MOOC is uniquely placed to be an important player in the country's effort towards affordable, high-quality, online education in the area of higher education.

Feedback/Suggestions

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