A short course on
Studies at high pressures by optical spectroscopy

6 June – 15 June 2017

OVERVIEW

Amongst all physical variables pressure is one of the most versatile tools for studies of fundamental interactions in matter. Increased pressure alters the energy of atomic bonds by forcing atoms closer together in a smaller volume and serves as a powerful probe of atomic interactions and chemical bonding. Furthermore, pressure is an important tool for synthesizing dense structures, including superhard materials, novel solidified gases and liquids, and mineral-like phases suspected to occur deep within the Earth and other planets. Pressures above 1 million atmospheres (100 GPa) can now be generated routinely using a diamond anvil pressure cell. The current maximum pressure obtained with such a device is 400GPa. Recent times one of the most burning topics in high pressure research is the metallization of hydrogen at high pressures. Hydrogen is the simplest element which makes up about 74% of the visible (baryonic) matter. Its phase diagram is of the great importance not only to the fundamental physics but also to the understanding of the planetary science. Due to the light mass of hydrogen, strong quantum effects govern its physical states at high densities, which can be produced by high pressures. However due to experimental needs to achieve such high pressures, various optical spectroscopy techniques have become very useful to the probe the state of the matter at extreme conditions of pressure.

Objectives and course details:

The aim of the course is to give an overview of the high pressure methodology and various spectroscopic techniques those have been used to study hydrogen at high compressions. The course will also look into the concepts of strong quantum effects that govern the material properties at high compressions. The course will be given by Prof. Isaac F. Silvera, Harvard University and his lectures will be built around the following topics in the span of about one and half week:

1. Techniques in high pressure physics, phase transitions under compression
2. High Pressure Phase Transitions in materials, e.g. solid Hydrogen at Low Temperature
3. Understanding the 1st order phase transition in metallic hydrogen
4. Hydrogen deuteride at high pressure
5. The physics of compression

Every morning there will be a one and half - hour lecture on the topics outlined above. This will be followed by tutorial and discussions. Tutorials will be based on concepts developed in the lecture and will be designed by the external expert. The local coordinator, together with PhD students, will conduct the tutorials. There will be ample opportunities for participants to interact with the expert throughout the duration of the course.

COURSE VENUE

Lecture Hall Complex
Indian Institute of Science Education and Research Kolkata
Mohanpur – 741 246, West Bengal, India

TARGET AUDIENCE

- The proposed course is aimed at 4th and 5th year BS-MS, Integrated PhD and PhD students of IISER Kolkata.
- Teachers and researchers from colleges and universities.

COURSE FEES

- Student participants: **₹2,000/-** (refundable caution money)
- Academics, Researchers and Teachers: **₹5,000/-**
- Industry participants: **₹10,000/-**
- Participants from abroad: **$200/-**.

The above fee includes all instruction material, computer use for tutorials and assignments, laboratory equipment usage charges, free internet facility.

THE FACULTY

Prof. Isaac F. Silvera is the Thomas D. Cabot Professor of Natural Sciences in the Harvard University, USA. His research area includes studies at ultra high pressures and physics of cold particles. Some notable historic discoveries at high pressures include the discovery of megabar pressure phases in solid hydrogen and its isotopes, the metallization of xenon at megabar pressures, the metallization of hydrogen iodide, and highest pressures for NMR in a diamond anvil cell. In the study of low temperature quantum fluids, the stabilization and confinement of the first magnetic gas, spin-polarized hydrogen, started the experimental search for Bose-Einstein condensation. His current research focuses on the metallization of solid hydrogen and the stabilization of multi-electron bubbles in superfluid helium.

Goutam Dev Mukherjee is an Associate Professor of Department of Physical Sciences at Indian Institute of Science Education and Research Kolkata and is currently Head of the Department. His research focuses on phase transitions in materials at extreme conditions of pressure and temperature.

COURSE CO-ORDINATOR

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IMPORTANT INFORMATION

- For course registration please visit: http://www.gian.iitkgp.ac.in/GREGN/index
- Registration Deadline: **10 April 2017**
- Fess to be paid by NEFT:
  - Name of the Beneficiary: IISER Kolkata Project A/c
  - Name of Bank and Branch: Indian Overseas Bank, Mohanpur
  - Beneficiary Account No.: 325001000000002
  - Bank MICR Code: 700020092
  - Bank IFS Code: IOBA0003250
- Accommodation based on nominal charges (per day) will be available to all participants. Participants need to bear their own accommodation and food expenses.
- After successful completion of the course, all participants will get participation certificates.
- No TA, DA will be provided to the participants.
- How to reach: http://www.iiserkol.ac.in/contactus/how-to-reach

ABOUT IISER KOLKATA

The Indian Institute of Science Education and Research (IISER) Kolkata was established in 2006 by the Ministry of Human Resource Development (MHRD), Government of India. This initiative was a part of the Government's effort to set up a number of new academic institutions of international standard that would train specialised manpower in basic sciences and allied technologies. Our central theme is to provide quality science education and to carry out research in basic and frontier areas of science involving both undergraduate and postgraduate students, in an intellectually vibrant atmosphere. Through borderless and flexible education programmes involving multi-disciplinary as well as inter-disciplinary curriculum, IISER Kolkata provides an unparalleled opportunity for young students to experience the excitements of research in basic sciences. In essence, IISERs are devoted to both teaching and research in an integrated manner – thus nurturing both curiosity and creativity. For more details please visit the link http://www.iiserkol.ac.in, and to reach **IISER Kolkata**, please see the link http://www.iiserkol.ac.in/contactus/how-to-reach .