

Science Day 2020, IIT Kanpur

Details of the Workshop on Space Science February 28, 2020

Session I : Chaired by Prof. Kumar Vaibhav Srivastava

Talk I: New dimensions of Indian hard X-ray Astronomy

Dr. Santosh Vadawale, Physical Research Laboratory, Ahmedabad

In the talk Dr. Vadawale discussed the achievements of the ASTROSAT observatory focussing on the CZTI instrument. It was exciting to learn that Indian efforts are providing polarimetric x-ray observations which may lead to major discoveries in future. Furthermore, the speaker described very impressive future probes to be launched by ISRO. One such probe is Daksha which is likely to revolutionize our understanding of the final stages of stellar life cycle.

Talk II: Understanding Black-holes in our Galaxy with LAXPC/AstroSat

Prof. J. S. Yadav, IIT Kanpur

Prof. Yadav described his work on x-ray binary stars using the LAXPC instrument aboard ASTROSAT. These binary stars are powered by a black hole and x-ray emission is observed from distances as close as twice the event horizon. He described his recent discovery which provides the first clear explanation of the Quasi Periodic Oscillations (QPOs) seen in these systems.

Talk III : How gravitational wave detectors measure sub-nuclear displacements?

Prof. Saikat Ghosh, IIT Kanpur

Prof. Ghosh described how such small displacements are measured by the LIGO gravitational wave detectors as well as work done in their own laboratory which is also able to observe displacements as small as the size of proton. The speaker nicely explained the basic concepts which involve amplification of the signal and a detailed understanding of the background noise.

Talk IV: Ultrafast table-top spectroscopy for Space Science

Prof. Debabrata Goswami, IIT Kanpur

In space science, femtosecond Lasers play important roles in demonstrating laboratory astrophysics to novel spectroscopy and broadband communication. The talk discussed certain aspects of these in general and then focused on the work from the laboratory of Prof. Goswami, which enables super-broadband coherent source generation as well as programming pulse shaping. A novel thermal spectroscopy developed in Prof. Goswami's lab that can remotely detect molecular composition and phase changes that could of immense use for planetary image investigations was also discussed.

Session II: Chaired by Prof. Abhishek

Talk I: Rings around minor planets **Mr. Bharath, IIT Kanpur**

The recent discovery of rings around small objects surprised scientists. Due to their small and irregular gravitational field it was thought that these objects were unable to hold the ring system. Speaker described his group's research work which aims to understand the formation and structure of these ring systems.

Talk II: Granular Minor Planets **Prof. Ishan Sharma, IIT Kanpur**

Prof. Ishan Sharma described his analytic and simulation work in order to understand the formation of minor planets by granular particles interacting with one another through gravitational force.

Talk III: Very Long Baseline Interferometric Technique - Its Applications in Geodetic Studies **Prof. B Nagarajan**

In the talk, the speaker described how Very Large Baseline Interferometric (VLBI) technique is now globally the preferred method for geodesy. VLBI is used in radio astronomy in order to measure positions of astronomical objects to very high accuracy. He put the argument that so far India does not have a geodetic VLBI system and explained why it is very important for it to acquire this technology.

Talk IV: Space Debris Mitigation **Mr. Akhil B. Krishna and Mr. Bharath, IIT Kanpur**

It was a joint presentation. They described a novel technique of disposing space debris by utilizing Solar Radiation Pressure generated by large reflective surfaces on a group of co-operative satellites. This pressure disposes the space debris either into the grave yard orbit or will push it such that it eventually gets re-enters the Earth's atmosphere

Talk V: In-situ data analysis to study the solar wind plasma **Prof. Supratik Banerjee**

Prof. Banerjee described his work on the study of solar wind plasma by in-situ analysis of plasma and electromagnetic field data.

Session III: Chaired by Prof. Sagar Chakraborty

Talk I: Gaia DR2 Informed Distance Constraint to the North Polar Spur

Mr. Kaustav K. Das, IIT Kanpur

The main objective of this work was to estimate the distance to the North Polar Spur (NPS), one of the largest structures in the Milky Way. The estimate is obtained by using optical and near-infrared photometric data which allows one to determine the frequency dependent attenuation of star light along the line of sight. A major conclusion of this study was that NPS is not associated with the Galactic Center or the Fermi bubbles as is commonly believed

Talk II: Where is the matter in our Universe and what is the matter with it?

Dr. Sharvari Nadkarni-Ghosh, IIT Kanpur

In her talk, Dr. Ghosh described how the matter is distributed in the Universe over a wide range of scales with the largest gravitationally bound structures, such as the recently discovered Saraswati supercluster, having distance scale of order 4000 million light years. Interestingly the visible matter is only about one sixth of the total matter. The remaining being dark matter whose precise nature is still unknown.

Talk III: Dark Energy: One of the greatest puzzles of Modern Science'

Dr. Suratna Das, IIT Kanpur

Dark energy dominates the energy content of the Universe and is even more mysterious than the dark matter described by the previous speaker. Dr. Das explained that the most likely source of this energy is the vacuum energy. However, a major mystery is that the fundamental theories of Physics predict vacuum energy some 10^{126} times larger than observed. The nature of dark energy remains a major puzzle.

Talk IV: GMRT discovery of a large ring of atomic hydrogen gas around a red and dead galaxy

Omkar Bait, National Center of Radio Astrophysics, Pune

The formation of such structures around galaxies is usually explained by a collision with another galaxy leading to an expanding density wave of gas and stars in the form of a ring. This would imply active star formation in the ring which, however, is not seen in the observed galaxy. Hence the observations suggest a new unknown mechanism for the formation of the ring.

Talk V: The staggering power of thunderstorms

B. Hari Haran, TIFR, Mumbai

Almost 100 years ago it was predicted that thunderstorms can generate huge voltages of the order of 1,000,000,000 Volts (1 GV). This prediction has now been verified by a very interesting measurement by the GRAPES-3 cosmic ray observatory at Ooty. Essentially the observatory measures the relative intensity of cosmic ray muons (negatively charged particles) and the anti-muons (positively charged particles) during a

thunderstorm. The difference is attributed to acceleration or deceleration caused by potential difference generated during such an event.

Talk VI: Shocking Granular Flows
Prof. Sanjay Kumar, IIT Kanpur

The speaker described their theoretical and experimental work on the study of shocks in granular medium. The sound speed in such a medium is relatively small and hence shocks can be generated and studied easily in laboratory.

Talk VII: Satellites as Gravimeters
Prof. Balaji Devaraju, IIT Kanpur.

Prof. Devaraju explained that the gravitational field of the Earth can be studied to very good accuracy by observing the positions of satellites. Hence they can be used as gravimeters. He discussed the application of this technique to understand geophysical processes and for climate change.