## IEEE Distinguished Lecture and an Academic-Government-Industry Workshop on Antenna Technologies for Space Applications

**Date:** October 14, 2025
**Venue:** IISc – Indian Institute of Science, Bangalore / India

Distinguished Professor Karu Esselle, *FIEEE*, *FRSN, FIEAust,* gave an extended one-and-a-half-hour IEEE Distinguished Lecture, in two parts, at the Indian Institute of Science (IISc) in Bangalore, India, which was attended by approx. 480 researchers, in person or online.

This was a highlight of an academic-industry-government IEEE Workshop on Antenna Technologies for Space Applications, organized by the IEEE AP-S/MTT-S Student Branch at IISc Bengaluru, in collaboration with Space Machines Company, under the umbrella of the Space MAITRI program - an Indo-Australian initiative advancing knowledge exchange, collaboration and innovation in satellite and space technology.

It was held whole day on October 14, 2025, and was addressed and attended by research leaders, researchers and research students (PhD and Masters) from academia, industry and governments including the Indian Space Research Organization (Space Applications Centre in Ahmedabad and Satellite Centre in Bangalore), exhibiting their enthusiasm while creating a vibrant intellectually rich environment for the day's sessions.

Subsequent to Karu's IEEE distinguished lecture, the following subject-domain experts delivered their presentations, each offering unique perspectives on advanced antenna technologies and space communication systems.

- Mr. Devendra Kumar Sharma (ISRO Space Applications Centre, Ahmedabad)
- Ms. Sreeja R (Space Machines Company)
- Professor Debdeep Sarkar (Indian Institute of Science, Bengaluru)
- Dr. Khushboo Singh (University of Technology Sydney)
- Prof. Mahadevan Vaidyanathan (ISRO Satellite Centre, Bengaluru)

**FIGURE 1**: Audience during Prof. Esselle's IEEE distinguished lecture and felicitation of Prof. Esselle after his lecture.

In his IEEE Distinguished Lecture (Fig. 1), Distinguished Prof. Esselle introduced the pioneering concept of Near-Field Meta-Steering, a transformative approach to beam steering that eliminates the need for mechanical tilting or the complexity of traditional phased arrays. By placing two independently rotatable phase-gradient metasurfaces in the near field of a fixed-beam antenna, the system achieves wide-angle beam steering - covering full 360° azimuth and broad zenith angles - while maintaining a compact, low-profile structure. He highlighted the global impact of this technique, also known as Near-Field Phase Transformation and Risley Prism, and its adoption by leading institutions such as Thales, WaveUp, TICRA, and UCLA.

Mr. Sharma delivered an insightful overview of antenna systems tailored for spaceborne platforms, emphasizing the critical constraints of mass, volume, and environmental resilience (Fig. 2). He articulated the foundational requirements for designing antennas suited to satellite missions, drawing from his extensive experience with RISAT-1A, RISAT-2A, and GSAT-7R. His presentation covered the development of deployable reflectors, reflectarrays, and phased arrays, with particular attention to polarization purity and structural integrity under the rigors of launch and orbital conditions. Bridging theoretical principles with real-world implementations, Mr. Sharma showcased flight-proven designs that have successfully operated in space.


**FIGURE 2**: (left) Mr. Devendra Sharma's presentation. (right) Felicitation of Mr. Devendra Sharma after his presentation.

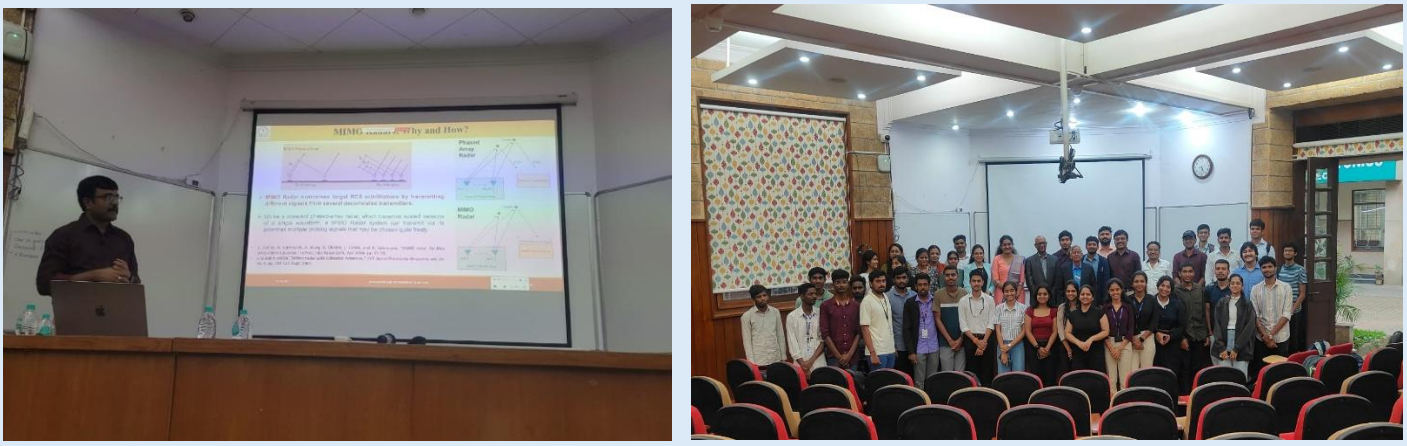
Ms. Sreeja R highlighted how the New Space ecosystem is driving demand for scalable, reconfigurable, and cost-efficient antenna architectures. She outlined the company's practical innovations in multi-band and modular antenna designs that support interoperability across satellite constellations. The presentation stressed manufacturability, integration with onboard systems, and the importance of academia–industry collaboration in transitioning research concepts into deployable space hardware (Fig. 3).

Prof. Sarkar explored the intersection of metasurface engineering and MIMO radar architectures, highlighting their relevance to next-generation space missions. He demonstrated how engineered surfaces can facilitate beam shaping, polarization control, and dynamic reconfigurability, all while maintaining a lightweight form factor—an essential attribute for satellite and deep-space applications. Drawing from research at the iDARE Laboratory, IISc, he presented both static and dynamic beam-steering structures based on anomalous reflection and the generalized Snell's law. His talk also emphasized the development

of reconfigurable intelligent surfaces and holographically designed metasurface antennas capable of dynamic 2-D beam steering without mechanical rotation. The session concluded with insights into adaptive beamforming and aperture control strategies for MIMO radar systems (Fig. 4).

(a) (b)

**FIGURE 3**: (a) Ms. Sreeja R sharing her experience on scalable, reconfigurable, and cost-efficient antenna architecture. (b) Felicitation of Ms. Sreeja R after her speech.

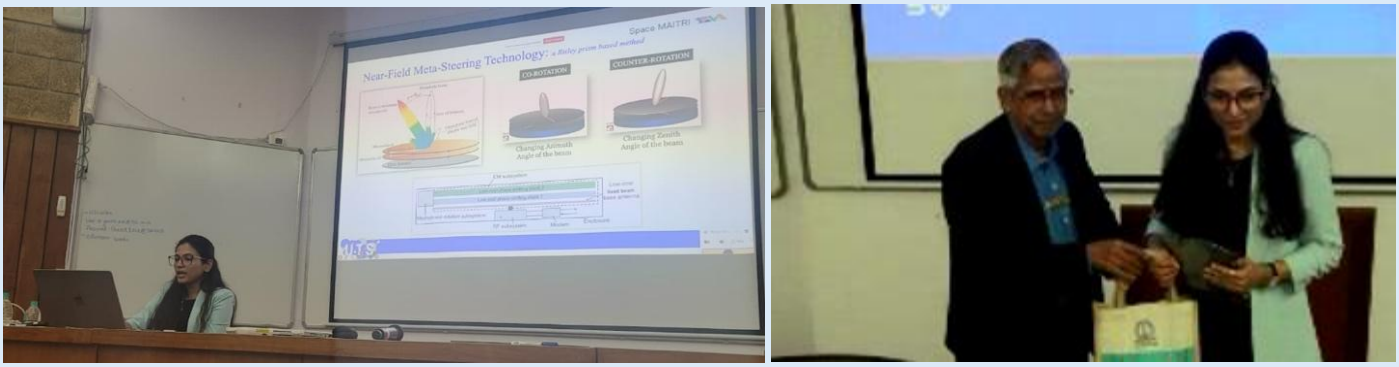


(a) (b)

**FIGURE 4**: (a) Prof. Sarkar explaining his research works in MIMO radars. (b) Group photograph taken post event.

Dr. Khushboo Singh delved deeper into the electromagnetic principles of Near-Field Meta-Steering, focusing on aperture-field transformation and local phase compensation (Fig. 5). She compared this approach with conventional phased-array steering, showing its advantages in low-power, broadband, and compact designs suitable for small satellites. Experimental validation confirmed substantial beam-deflection capability without active phase control, pointing toward next-generation beam-agile systems.

Prof. Vaidyanathan concluded the workshop with an in-depth discussion on spacecraft antenna systems, addressing extreme operational environments and longevity requirements. He showcased examples ranging from omnidirectional handheld antennas to phased arrays with ultra-low sidelobes, accompanied by hardware images (Fig. 6). His lecture highlighted design qualification, vibration testing, and the evolution of ISRO's antenna technology from early missions to present-day satellites.




(a) (b)

**FIGURE 5**: (a) Dr Khushboo Singh explaining Near-Field Meta-Steering. (b) Felicitation of Dr Khushboo Singh.


(a) (b)

**FIGURE 6**: (a) Prof. V Mahadevan's presentation. (b) Felicitation of Prof. V Mahadevan after his speech.

The IEEE Workshop on 'Antenna Technologies for Space Applications provided a rich forum for exchanging knowledge between researchers and practitioners. By integrating academic insights, industrial experiences, and international collaborations under the Space MAITRI Mission, the workshop advanced the vision for next-generation antenna systems in space communication and sensing.

Feedback collected through post-event surveys reflected high satisfaction regarding content quality, speaker expertise, and event organization, with the majority rating the IEEE workshop excellent. For example, here are some comments by attendees:

- "What I liked the most was the way it connected theoretical concepts with real-world applications. I found it fascinating to learn how different antenna designs are used in satellites and space communication systems. The practical insights shared by the experts helped me understand how antennas play a critical role in reliable data transmission in space."

- “I came to know that there are antenna designs that help rotate the whole wave, instead of tilting and rotating the antenna source.”
- “It was fun to learn from the experience of people whose expertise is in this field, and the topic was very interesting.”
- “The way workshop conducted was amazing; all the guest speakers were so enthusiastic and made the sessions interactive.” “
- A well-designed workshop.”

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