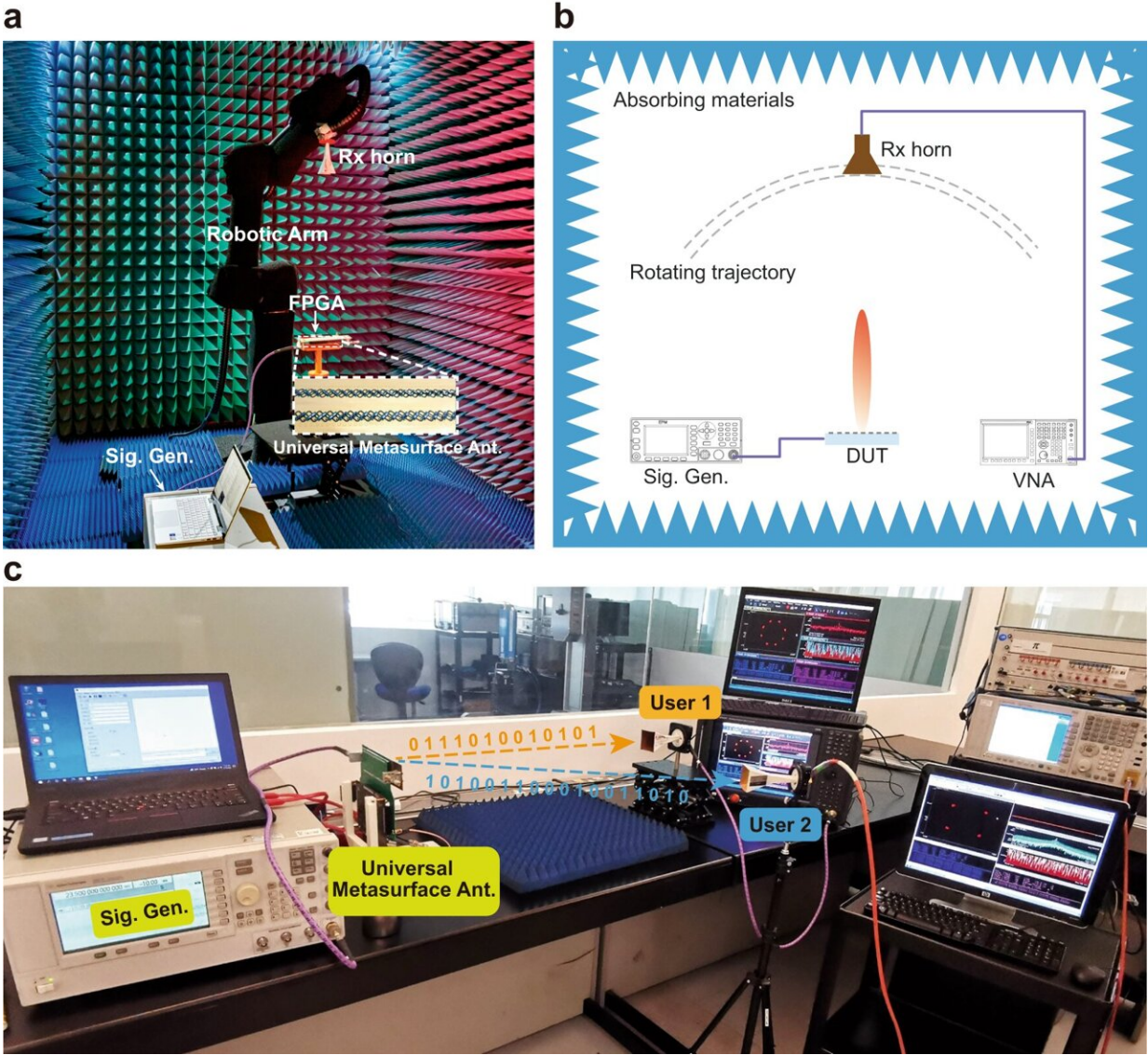


# Researchers develop world's first universal metasurface antenna for high-security 6G communications

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a, b Photograph and schematic of the measurement setup for radiation pattern measurement of the UMA. c Dual-channel wireless communications link testbed, in which the UMA directly and simultaneously generates two independent modulated waveforms carrying different information. Two horn antennas connected to two vector signal analyzers (VSAs) are used to receive and demodulate the signals. DUT device under test, VNA vector network analyzer, Rx receiver, Sig. Gen. signal generator. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-40717-9

A research team led by Professor Chan Chi-hou, Chair Professor of Electronic Engineering at City University of Hong Kong (CityU), achieved an unprecedented advance in antenna technology by making possible the manipulation of all five fundamental properties of electromagnetic waves through software control.

In a world first, the team developed a universal metasurface antenna that allows the independent and simultaneous manipulation of amplitude, phase, frequency, polarization and direction of electromagnetic radiation.

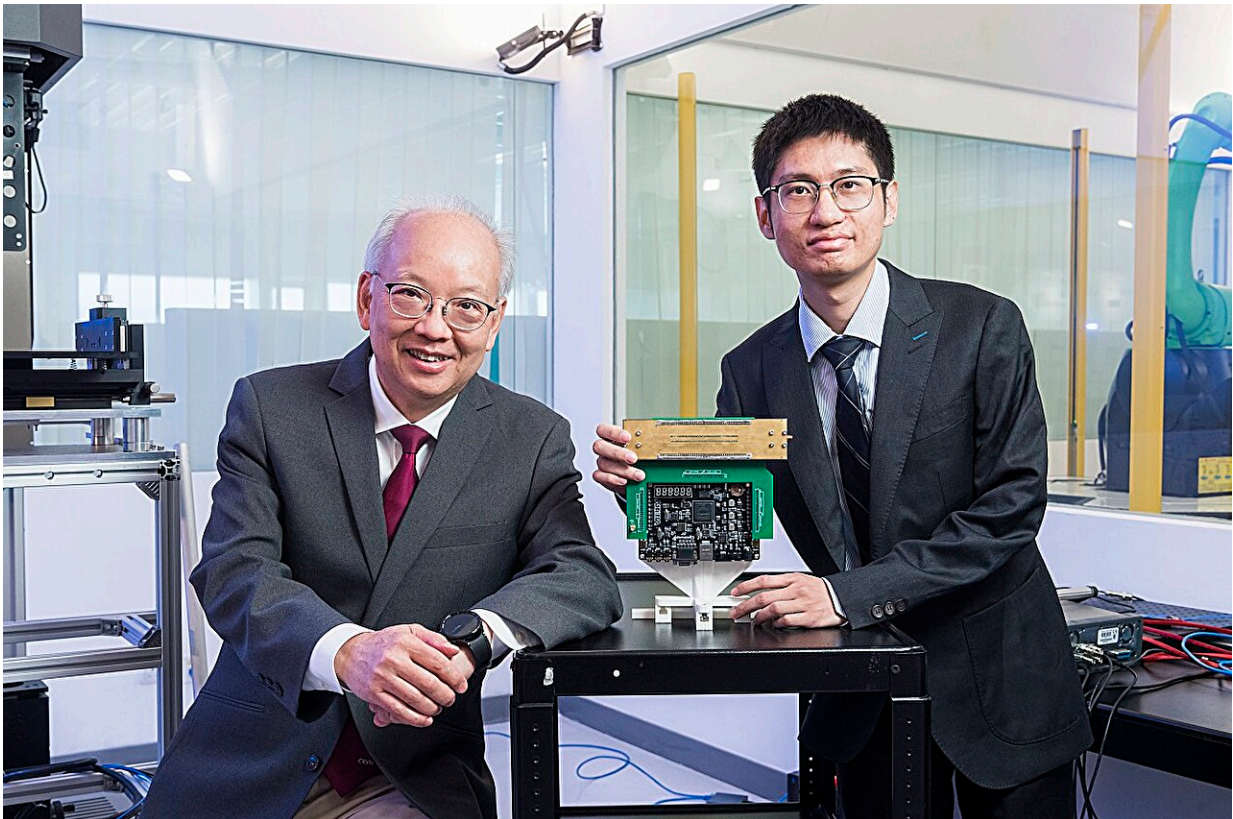
"A universal component capable of manipulating all the fundamental wave properties is the Holy Grail for physicists and engineers," said Professor Chan, who is also Director of the State Key Laboratory of Terahertz and Millimeter Waves (SKLTMW).

As research on 6G [wireless communication systems](#) progresses worldwide, the universal metasurface antenna holds immense potential for various applications in 6G systems. Its advanced waveform manipulation capabilities and enhanced [security features](#) are crucial for integrating sensing and communications.

The universal metasurface antenna can be used for next-generation, large-

capacity, high-security information systems, [real-time](#) imaging, and wireless power transfer. The antenna's inherent direction modulation properties also enhance privacy and security, making it an ideal candidate for eavesdropper-proof communications.

The paper, titled "A universal metasurface antenna to manipulate all fundamental characteristics of electromagnetic waves," was [published](#) online in *Nature Communications*.



Professor Chan Chi-hou (left) and Professor Wu Gengbo (right) showcase the universal metasurface antenna developed at CityU, which allows unprecedented manipulation of electromagnetic waves. Credit: City University of Hong Kong



Professor Wu Gengbo, from the Department of Electrical Engineering and a SKLTMW member, explained that the universal metasurface antenna can manipulate information by directly generating the modulated waveform in free space.

"We hope that the universal metasurface antenna can work as a simplified information transmitter with low cost, high integration and [low power consumption](#)," said Professor Wu, who is the first author of the paper.

Dr. Dai Junyan, a former postdoctoral fellow with the SKLTMW, is the paper's co-first author. Academician Cui Tiejun and Professor Cheng Qiang, both from Southeast University, Nanjing, China, as well as Dr. Dai and Professor Chan are the corresponding authors. Dr. Keeson Shum Kam-man and Dr. Chan Ka-fai are Senior Engineers with SKLTMW.

This achievement was made possible through collaboration between CityU and Southeast University. Professor Chan emphasized that the partnership between the two institutions was essential for tackling complex research challenges and achieving the groundbreaking results.

"The joint expertise and resources from both universities facilitated the successful development of the universal [metasurface antenna](#), bringing together diverse perspectives and knowledge," said Professor Chan.

Professor Chan said the invention introduces new features to integrating sensing and communications, paving the way for exciting possibilities in the future.

**More information:** Geng-Bo Wu et al, A universal metasurface antenna to manipulate all fundamental characteristics of electromagnetic waves, *Nature Communications* (2023). [DOI:](#)

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Provided by City University of Hong Kong

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