# 亮点报道：环境能量驱动时空编码超表面——一体化实现能量收集+电磁调控+信息调制

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可编程超表面，又称可重构智能表面 (RIS)，由于能够自由、灵活地调控电磁波，并具有低成本、低复杂度和高集成度等优点，已被视为未来无线通信的一种关键使能技术。

东南大学蒋卫祥教授和崔铁军院士团队提出一种环境能量驱动时空编码超表面 (ASTCM)，通过将太阳能电池芯片高度集成到每个超表面单元上，能够动态、灵活调控反射电磁波的频谱分布和空间传播特性，并通过共享同一物理孔径自主收集环境太阳能。该研究团队开发了一种创新的时空编码方法，使得 ASTCM 能够同时在多个谐波频率下实现独立的多波束赋形。通过利用这种多频多波束赋形能力并进一步调制每个波束的相位，可高效复用不同频率和空间资源，进而构建多个独立的信息传输通道。

这种环境能量驱动时空编码超表面技术创新地在单一超表面物理平台上一体化实现了环境能量收集、电磁波调控与直接信息调制，为未来无线通信实现大容量传输、多用户接入、高能效和绿色可持续发展开辟了一条全新的路径。

# Highlights: All-in-one realization of energy harvesting, electromagnetic wave manipulation and information modulation

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Programmable metasurface, also termed as reconfigurable intelligent surface (RIS), have emerged as a transformative enabling technology for future wireless communications due to their ability to freely and flexibly manipulate electromagnetic waves, complemented by advantages such as low cost, low complexity, and high integrability.

The Prof. Weixiang Jiang from Southeast University and the team of Academician Tiejun Cui propose an ambient-energy-driven space-time-coding metasurface (ASTCM) by heterogeneously integrating a solar cell chip onto each meta-atom to achieve the dynamic control of reflected EM waves and harvest ambient solar energy through sharing the same physical aperture. An innovative space-time coding method is developed, enabling the ASTCM to achieve independent multi-beamforming at multiple harmonic frequencies simultaneously. By utilizing this multi-frequency multi-beamforming capability and further modulating the phase of each beam, different frequency and space resources can be efficiently multiplexed for constructing multiple independent information transmission channels.

This ASTCM technology innovatively integrates ambient energy harvesting, EM wave manipulation, and direct information modulation onto a single metasurface physical platform, opening up a brand-new path for future wireless communication to achieve high-capacity transmission, multi-user access, high energy efficiency, and green and sustainable development.

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