Quantum remote sensing: a road path for future remote sensing technique

Lei Yan，Zihan ZHANG, Feizhou ZHANG, Yi LIN, Zhaoyu LIU

Beijing Key Lab of Spatial Information Integration and 3S Application, Institute of Remote Sensing and Geographic Information System, School of Earth and Space Science, Peking University, Beijing 100871, China

**Presenting author (lyan@pku.edu.cn)*

The electromagnetic wave equation defines scalar remote sensing through four primary components: amplitude, wave vector direction, wavelength, and time, which respectively establish radiation, spatial, spectral, and temporal resolutions. Polarization, an intrinsic property of electromagnetic transverse waves, introduces an orthogonal two-dimensional vector to the direction of light propagation, presenting an independent information dimension beyond the initial four parameters. Integrating polarization resolution into conventional scalar remote sensing methodologies represents the sole pathway to unlocking additional optical remote sensing information and advancing quantification capabilities. From a quantum mechanics standpoint, polarization enables a comprehensive description of photon states, potentially elevating optical remote sensing to quantum levels of precision. Despite the widespread deployment of high-resolution, multi/hyperspectral satellite payloads globally, polarization-sensitive instruments remain scarce, with a notable absence of high-resolution polarization payloads. Current satellite-borne remote sensing systems are thus limited to either non-polarized high resolution or polarized low-resolution configurations. The future progression of remote sensing hinges on transitioning from scalar to vector methodologies, yet comprehensive theories and technologies supporting vector remote sensing are presently underdeveloped. This study aims to investigate vector remote sensing mechanisms, focusing on quantum polarization-based high-resolution spectral imaging methods as a fundamental exploration platform.

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