PIER Photonics

Editorial Highlight

Singular Jones Metasurfaces — Polarization Addressability and Topological Phase Winding

Sailing He[1, 2, *]

[1] *School of Electrical Engineering, Royal Institute of Technology, S-100 44 Stockholm, Sweden*
[2] *Center for Optical and Electromagnetic Research, Zhejiang University, Hangzhou 310027, China*

As we launch *PIER Photonics* with a clear focus on the frontiers and hot topics of the field, it is my great pleasure to introduce the very first paper of our inaugural issue: **"Polarization-Addressable Singular Jones Metasurfaces,"** first-authored by Dr. Haoye Qin (National University of Singapore), along with Prof. Cheng-Wei Qiu (National University of Singapore) and Prof. Qinghua Song (Tsinghua University), and their collaborators [1].

Prof. Cheng-Wei Qiu and Prof. Qinghua Song serve as the corresponding authors of this work — the same role they held for a *Nature* paper [2] published last year, on which Dr. Qin was also the first author. That *Nature* paper explored topological photonic crystals, a closely related field that shares the same spirit of manipulating light through structural engineering. This track record is a testament to the research excellence that *PIER Photonics* aspires to feature. I am delighted that this outstanding contribution has chosen *PIER Photonics* as its home.

This work exemplifies exactly the kind of transformative research that we established this journal to showcase.

Scientific and Theoretical Significance

This work represents a significant advance in the field of singular optics, elevating the concept from conventional field-level singularities — whether scalar phase vortices or vectorial polarization textures — to the level of the input-output operator itself. By engineering reflective plasmonic metasurfaces to satisfy the zero-determinant condition of the Jones matrix, the authors demonstrate a polarization-addressable matrix-level singularity that maps a nonzero incident eigen-polarization to a vectorial zero output. This is achieved through destructive interference between orthogonal polarization components, opening an entirely new degree of freedom for light manipulation.

A particularly impressive aspect of this work is the demonstration of full Poincaré-sphere addressability. By tailoring the geometry of the meta-atoms, the eigen-polarization of the zero-output state can be continuously tuned across the entire Poincaré sphere. Encircling the singularity in a two-dimensional structural parameter space yields a complete 2π topological phase winding, which manifests as a robust twofold topology when projected onto any orthogonal basis. This duality is not only conceptually elegant but also holds considerable potential for engineering applications, enabling dual-channel meta-holography and vortex beam generation.

The study further bridges metasurface engineering with non-Hermitian photonics by pushing the system toward extreme symmetry breaking. In this regime, the eigenstate approaches circular polarization (a C-point), corresponding to an exceptional point of the Jones matrix where the two eigenvalues coalesce to zero. This chiral Jones singularity provides an intrinsic mechanism for handedness-selective extinction, offering a compact route to chiral light-matter interactions.

Potential Applications

From an applications perspective, the demonstrated capabilities are highly compelling. The topological phase winding enables multi-channel holographic displays with high security for optical encryption and data storage. The chiral selectivity holds promise for ultrasensitive biochemical sensing and enantiomer detection. Meanwhile, the generation of optical vortices with controllable orbital angular momentum provides a compact on-chip platform for OAM-multiplexed communications, optical trapping, and high-dimensional quantum entanglement.

Overall, this work establishes a unified metasurface platform that integrates polarization extinction, topological wavefront control, and chiral selectivity — three functionalities that have traditionally required separate optical systems. It is a testament to the power of matrix-level singularity engineering and a timely contribution that embodies the ambitious, paradigm-shifting research *PIER Photonics* aspires to publish as it begins its journey as a premier journal in the field.

I warmly congratulate Dr. Haoye Qin, Prof. Cheng-Wei Qiu, Prof. Qinghua Song, and their co-authors on this outstanding contribution. I also extend my sincere gratitude to the authors for trusting *PIER Photonics* with their work. I look forward to presenting many more groundbreaking discoveries from the global photonics community in the pages of our journal.

Join us in building a home for photonics' frontiers and hot topics.

REFERENCES

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* Editor-in-Chief and Corresponding author: Sailing He (sailing@kth.se).

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