Editorial
Introduction to JSTQE Issue on Photonics for Synthetic Dimension and Topological Insulators

WELCOME to the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS (JSTQE) Issue on Photonics for Synthetic Dimension and Topological Insulators!

The idea of synthetic dimensions was originally introduced in the context of atomic physics, where under a suitably designed optical dressing the Zeeman sublevels of a given electronic state can be seen as an additional spatial dimension; the higher the spin, the larger the number of sites in this synthetic dimension. In photonics, this idea can be pushed much further using multimode resonators which host a huge number of almost equispaced modes such as ring-resonators. In a lattice of such resonators, the physical dimensions are in this way supplemented by a synthetic dimension corresponding to the mode index, which can be naturally addressed via frequency-multiplexing techniques. Recent work has pointed out that tunnel-like coupling along the synthetic dimension can be generated by means of a suitable temporal modulation of the optical properties of the resonator, e.g. via a strong optical pump beam driving the optical nonlinearity of the resonator medium. On the other hand, topological photonics has been a hot topic in the theoretical and applied physics communities, introducing concepts such as protected topological states and robust optical transport channels that maintain their functions even in the presence of significant disorder and imperfections.

This issue aims at offering a forum to discuss new concepts in the area of topological photonics and of optoelectronic devices whose operation relies on topological features.

The issue contains 7 papers, where topological photonics concepts are introduced and discussed with specific attention to practical implementations. You will find a paper on topological edge modes in a rhombic waveguide array with imaginary coupling which allows to discuss the wave dynamics of both bulk and edge modes. Another paper presents results about an active magneto-optic Pancharatnam-Berry metasurface to control terahertz (THz) waves. A paper addresses the issue of using quantum phenomena to improve detection, identification, and resolution capabilities of a radar. A paper reports on the achievement of unidirectional and backscattering immune propagation of terahertz optical waves in a topological valley-Hall waveguide made of graphene nanohole plasmonic crystals. A plasmonic in-plane zone-plate (IPZP) is proposed to obtain high performances with a strong fabrication tolerance over various operating wavelength for orbital angular momentum communication and high dimensional quantum entanglement. Another paper demonstrates a periodically poled LiNbO3 (PPLN)-based OPO to generate arbitrarily beams whose polarization states and wavelengths can be readily controlled. Finally, a last paper reports on numerical simulation of various ring topologies to get Skyrmion-like topological excitations in a two-dimensional spin-1/2 system.

We hope you will find this JSTQE Issue on Photonics for Synthetic Dimension and Topological Insulators to be an interesting adds-on that will impact, stimulate and promote further advances in Photonics.

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