Harnessing high-dimensional topological defects in spontaneous ferroelectric photonic supercrystals

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Complex ferroelectric domain structures have attracted great attention both for the understanding of how topology emerges spontaneously in nature and as innovative platforms for nonlinear and quantum optics applications. Recent experiments have revealed how the 3-axis broken-inversion-symmetry transition associated to the ferroelectric transition in lithium-enriched potassium-tantalate-niobate leads to the formation of mesoscopic extended 3D periodic lattices of high-dimensional spontaneous polarization topological defects. These supercrystals scatter light like xray diffraction, but at visible and near-infrared wavelengths, and manifest giant refractive properties for light propagating inside the strings of the single defects. The result is an entirely new state of matter with remarkable optical properties, from constraint-free wavelength conversion to achromatic light transmission, whose understanding is still in the making. What emerges as the basic supercrystal building block, a hyper-vortex formed of the combination of six interlaced polarization vortices, holds the promise of a topologically-protected optically-addressable memory in 3D, a potentially key ingredient for ultra-compact and stable next-generation ferroelectric memory.

Short Bio:

Eugenio DelRe is a Professor of Experimental Condensed Matter Physics at the University of Rome La Sapienza. He carries out experimental research in nonlinear optics focusing on photonics in proximity of structural phase transitions.