Taming Light in Complex Aperiodic and Accelerating Photonic Lattices

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Artificially tailored photonic structures are one of the most promising concepts for the realization of functional optical systems capable to control, route and steer light accompanied with a manifold of integrated functionalities.In contrast to light propagation in prefabricated permanent structures, an increased flexibility can be achieved when light itself induces its own structure through the nonlinear response of the material. This so-called optical induction of refractive index modulations represents a highly versatile, flexible, and scalable approach to structure photosensitive materials. Photonic graphene, photonic quasicrystals and photonic random lattices are among the versatile lattices with specific band gap structures that have been successfully employed to demonstrate quantum effects. Moreover, the interplay between periodicity and nonlinearity in these structures has been shown to cause a variety of fascinating nonlinear effects, among them discrete solitons, Zener Tunneling and Bloch oscillations..

In our contribution, we present various approaches enabling the fabrication of aperiodic to random, spiral, or accelerating lattices.The resulting functional photonic systems are subsequently used to probe complex light propagation such as chiral or vortex-bearing light fields carrying orbital angular momentum. The light-matter interaction results in striking effects as oscillating solitons, Anderson localization and coherent backscattering, or controlled self-acceleration in Airy and caustic lattices.