In recent years, notions drawn from non-Hermitian physics and parity-time (PT) symmetry have attracted considerable attention. Along these lines, the prospect of utilizing both optical gain and loss has emerged as a new paradigm in shaping the flow of light. By harnessing such concepts, recent works indicate that novel synthetic materials, structures, and devices with counter-intuitive properties and functionalities can be realized – potentially enabling new possibilities in the field of optics and integrated photonics. These include for example unidirectional invisibility effects, loss-induced transparency, band merging, and new classes of single-mode micro-lasers with improved lasing characteristics. Some of these possibilities, observed in linear and nonlinear lattice environments, are depicted in Fig. 1. Non-Hermitian degeneracies, also known as exceptional points (EPs), have also emerged as a new design tool for engineering the response of optical systems.

These non-Hermitian degeneracies are by themselves interesting entities. As opposed to standard degeneracies, at an EP, not only do the eigenvalues coalesce but so do the corresponding eigenstates. In fact, at such bifurcations, the relevant eigenvectors collapse on each other and as a result, the dimensionality of the system is abruptly reduced. This in turn has a profound effect on how the system responds to a perturbation. In this case one can show that when a perturbation of strength $\varepsilon$ acts on an Nth-order EP (when N eigenvalues and eigenvectors merge), the resulting eigenvalue (frequency) splitting is now proportional to $\varepsilon^{1/N}$. This indicates that the sensitivity of a set-up can be enhanced by several orders of magnitude by exploiting the physics of EPs.

Among many different non-conservative photonic configurations, parity-time (PT) symmetric arrangements are of particular interest since they provide an excellent platform to explore the physics of EPs for enhanced sensing applications. The enhanced response experimentally observed in a PT-ternary sensing system is shown in Fig. 2.

In this talk, we provide an overview of recent developments in this newly emerging field. The use of other type symmetries in photonics will be also discussed.