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### **Topological Vortex Domains in Quantum Materials<sup>1</sup>**

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Engineering of domains and domain walls is quintessential for technological exploitation of numerous functional materials. However, it has only recently realized that the configuration of these domains/domain walls can have non-trivial topology. We will discuss a new topological classification scheme of domain/domain boundary configurations with Ising-type or two-dimensional order parameters:  $Z_m Z_n$  domains ( $m$  directional variants and  $n$  translational antiphases) and  $Z_l$  vortices (where  $l$  number of domains and that of domain boundaries merge). This classification, with the concept of topological protection and topological charge conservation, has been applied to a wide range of materials such as (hybrid) improper ferroelectrics, chiral ferromagnets, and magnetic superconductors. We will also discuss the emergent physical properties at domain walls, distinct from those of domains. The presented topological consideration provides a basis in understanding the formation, kinetics, manipulation and property optimization of domains/domain walls in quantum materials.

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