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Abelian and non-abelian topological phases with dipoles

ALEXEY GORSHKOV, Joint Quantum Institute

Topological phases of matter offer a pathway towards fault-tolerant topological quantum computers, in which quantum information is encoded in nonlocal (topological) degrees of freedom and is processed robustly by braiding (i.e. moving around one another) topological defects called anyons. In this talk, we will develop schemes for taking advantage of the tremendous degree of control recently achieved in atomic, molecular, and optical systems – particularly in systems of interacting dipoles – to realize exotic topological phenomena, such as parafermions, Ising anyons, and Fibonacci anyons, that ultimately allow for universal topologically protected quantum computing.