From Skyrmions to Majoranas: the impact of atomic-resolution spin-resolved microscopy and spectroscopy

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Modern solid state physics has become greatly inspired by particle physics theories in recent years. The reason is that quasiparticles are a very useful concept for understanding complex phenomena in many-body physics. Recent outstanding examples are Skyrmions as topological defects in vector fields characterized by a topological charge [1], or the Majoranas, i.e. particles being their own antiparticles [2]. In the introductory part of the lecture, I will focus on experimental techniques, such as spin-resolved scanning tunneling microscopy and spectroscopy [3], which were crucial for recent progress in these fascinating fields of solid state physics. I will then focus on the discovery [4] and fundamental aspects [5] of single chiral magnetic skyrmions in ultrathin metallic films as well as their potential applications in future ultrahigh-density magnetic memory and logic devices [6]. In the second part, the lecture will focus on the concept of and exciting search for Majoranas in atomic-scale model systems [7,8] with great potential for future quantum information and communication technologies [9].

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