# Even and odd parity wave unconventional magnets

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Heisenberg's spin-dependent exchange interaction is the cornerstone of the century-old field of quantum physics and magnetism. It explained the microscopic mechanism of the parallel spin ordering in ferromagnetic crystals. The corresponding principally isotropic s-wave spin polarization in the electronic band structure is akin to s-wave Cooper-pairing in conventional superconductors. In this talk we will focus on the recent discovery of altermagnets with d-wave (or higher even-parity wave) spin polarization which has opened a new chapter in magnetism. It is analogous to the expansion of the field of superconductivity, following the discovery of unconventional d-wave pairing in the strongly correlated cuprates. Remarkably, altermagnetism can be realized by spin ordering in crystals via the Heisenberg exchange, i.e., by comparably basic, uncorrelated and robust quantum physics to that underpinning ferromagnetism. After briefly recalling precursor studies, we start our talk by reviewing the unique features of the even-parity-wave unconventional magnetism. This will be based on the symmetry description of the spin-density ordering in the altermagnetic crystals and of the corresponding spin-polarizatin in the electronic spectra. The spin-symmetry approach has recently also led to the identification of unconventional p-wave magnets. They represent a robust magnetic-exchange counterpart of the delicate macroscopic quantum phase of superfluid $^3$He with the p-wave pair correlations. While enabled by the basic physical principles known since early quantum mechanics, the unconventional magnets attract attention in a number of modern science and technology fields. In the frontier research ranging from relativistic, topological or correlated physics, to ultra-scalable spin-dependent information technologies, unconventional magnets remove principle limitations stemming from the presence of magnetization in conventional ferromagnets, or absence of spin-polarized bands in conventional antiferromagnets. In the second half of the talk we will give an overview of the broad relevance of unconventional magnetism, and of initial experimental evidence.

## References

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