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Dirac operators with magnetic links

The existence of zero modes for Dirac operators with magnetic fields is the cause of break down of stability of matter for charged systems.

However the known examples are geometrically complex, and a complete classification of zero modes is unknown. In particular, one does not know the characteristics of the magnetic fields which produce the zero modes.

To better understand them, we studied the particular case of magnetic fields with finitely many field lines which form a link. These singular fields can be seen as generalizations of the Aharonov-Bohm solenoids, and they exhibit the same 2π-periodicity of the fluxes carried by their field lines.

Tuning one flux from 0 to 2π gives rise to a loop of Dirac operators for which we can study the spectral flow, a non-trivial spectral flow indicating the occurence of zero modes. It turns out that this number depends on the geometry of the magnetic fields: the interlinking of the field lines but also their shapes.

(Joint work with Fabian Portmann and Jan Philip Solovej)