Long-wavelength incommensurate spin structure mediated by relativistic electrons in NdAlSi

Jonathan Gaudet
Postdoc, Department of Physics and Astronomy
Johns Hopkins University

Weyl semi-metals are topologically nontrivial phases of matter that sustain low energy excitations described by massless fermionic quasi-particles. Weyl fermions can be stabilized in crystals that break inversion or time-reversal symmetry. NdAlSi has a non-centrosymmetric crystal structure and is also magnetic, so it breaks both of these symmetries. NdAlSi is thus an excellent template to study the connection between magnetism, electronic transport, and the Weyl fermions. To do so, we characterized the magnetism of NdAlSi using neutron diffraction and found a ferrimagnetic state at low temperature, which is followed by a long-wavelength incommensurate order at finite temperature. A combination of quantum oscillations measurements and DFT calculations were then performed to determine the Fermi surface of NdAlSi. We found that the periodicity of the magnetic order in NdAlSi matches the momentum space vector that connects two of its Fermi pockets. The Fermi pockets involved in this interaction contain Weyl fermions, which raises the interesting possibility for magnetic order driven by relativistic electrons in NdAlSi.

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