A061-05-280823

The double-Q ground state with topological charge stripes in the skyrmion candidate $GdRu_2Si_2$

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Keywords: skyrmions, multi-Q, centrosymmetric

GdRu2Si2 is a centrosymmetric magnet in which skyrmion and meron lattices have recently been discovered [1,2]. The stabilisation of these extraordinary spin-textures in centrosymmetric materials is of great interest, since it is possible to realise these topologically non-trivial spin textures without a magnetic field, which is not possible in non-centrosymmetric materials which rely on the Dzyaloshinskii-Moriya interaction. The absence of magnetic field to stabilise these spin configurations significantly increases the likelihood of developing a widespread spintronic device which uses the range of emergent phenomena in these systems.

Here, we present a time-of-flight neutron experiment on single crystal and polycrystalline ^{160}GdRu2Si2 in which we have discovered a new double-Q incommensurate magnetic ground state [3]. In addition to observing the **q**1 and **q**2 propagation vectors, we have found magnetic satellites of the form **q**1+2**q**2. The appearance of these satellites are explained within the framework of a constant moment solution. Using powder diffraction we have implemented the first quantitative refinement of this model. The structure, which contains vortex-like motifs, is shown to have a novel one-dimensional topological charge density. More generally, this work establishes that GdRu2Si2 has a wealth of topologically non-trivial spin textures and is therefore an ideal setting in which phase transitions between distinct topological structures can be experimentally probed.

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2. N. D. Khanh *et al.* Zoology of multiple-Q spin textures in a centrosymmetric tetragonal magnet with itinerant electrons, Adv. Sci. 9, 2105452 (2022).
[3] G. D. A. Wood *et al.* The double-Q ground state with topological charge stripes in the skyrmion candidate $GdRu_2Si_2$, (submitted) Phys. Rev. B. Letter (2023).