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Advanced Research Lab / Master Thesis

Observation of Skyrmions in Bulk Intermetallic Alloys

Skyrmions, topologically stable magnetic textures, have garnered significant interest for their potential applications in spintronics and data storage [1]. While extensively studied in thin films and multilayers, their presence and behavior in bulk intermetallic alloys remain relatively unexplored. This work aims to investigate the existence and properties of skyrmions in intermetallic alloys, focusing on understanding their formation mechanisms, stability, and manipulation with atomic insertion.

Methodology:

1. Material Synthesis: Synthesize intermetallic alloys and oxides with suitable crystal structures and magnetic properties using methods such as arc melting, mechanical alloying, sol-gel, solid state reaction, etc.

2. Microstructural Characterization: Employ techniques like scanning electron microscopy (SEM), and X-ray diffraction (XRD) to analyze crystal structure, grain morphology, and phase composition.

3. Magnetic Measurements: Utilize SQUID magnetometry and vibrating sample magnetometry (VSM) to investigate magnetic properties such as magnetic ordering and magnetization.

4. Observing Skyrmions: Employ advanced microscopy techniques including magnetic force microscopy (MFM) to directly observe skyrmions under varying conditions of temperature and magnetic field.[2]

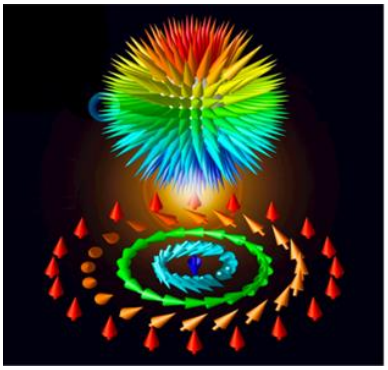

Figure 1: Representation of topological charge (top) of the skyrmion (bottom).[1]

Expertise to be gained:

- Bulk intermetallic and oxide compound synthesis.
- Proficiency in advanced microscopy techniques such as MFM.
- Understanding of the principles governing skyrmion formation and dynamics in bulk materials.
- Magnetic measurements and data interpretation.

References:

[1] Y. Tokura and N. Kanazawa, "Magnetic Skyrmion Materials," *Chemical Reviews*, vol. 121, no. 5. American Chemical Society, pp. 2857–2897, Mar. 10, 2021. doi: 10.1021/acs.chemrev.0c00297.

[2] A. K. Srivastava *et al.*, "Observation of Robust Néel Skyrmions in Metallic PtMnGa," *Advanced Materials*, vol. 32, no. 7, Feb. 2020, doi: 10.1002/adma.201904327.

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