Title:	Skyrmions and antiskyrmions in spin-orbit modified double exchange models
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Abstract: It has been understood that the conventional electronics based devices will not be able to meet the ever increasing requirements for data storage and processing of the modern world. Among others, the idea of utilizing the spin degree of freedom asso- ciated with electrons has been considered as a potential alternative. This has given rise to a new research eld, popularly known as spintronics, wherein electron's spin is used as the carrier of information for device functionalities. While it is not easy to detect and utilize spin of a single electron in materials containing a large number of them, certain magnetic con gurations show a desired stability and possible con- trol via external electric or magnetic eld. Therefore, search for magnetic materials supporting certain stable magnetic textures has become a key theme of research in recent years. Topologically protected magnetic textures, such as skyrmions and anti- skyrmions are of special importance due to their stability. Such textures have been discovered in chiral magnets and in thin lms of a variety of magnetic metals. The fundamental physics associated with formation of magnetic skyrmions has fascinated researchers since the discovery of these topological textures. The current approach to understand these intriguing textures is via spin models consisting of Dzyaloshinskii-Moriya (DM) interactions or frustrating long range interactions. In this thesis, we present a microscopic mechanism for skyrmion and antiskyrmion formation in metals that emerges from electronic itinerancy. We derive and study a microscopic spin Hamiltonian on a lattice for double exchange metals modi ed by the Rashba and Dresselhaus spin orbit coupling (SOC). In our model, anisotropic interactions of the Dzyaloshinskii-Moriya (DM) and pseudo dipolar form emerge naturally in addition to the standard isotropic term. We present phase diagram of the e ective spin Hamilto- nian which has veryinteresting ground states like classical spin liquid state using large scale Monte Carlo simulations. We show that in presence of Zeeman eld the mecha- nism we propose not only provides an accurate microscopic understanding of existence of skyrmions, but also explains key features in small angle neutron scattering (SANS) and Lorentz transmission electron microscopy (LTEM) data on thin lms of MnSi- type B20 metals and transition metals and their alloys. We identify hexagonal and square lattice arrangements of skyrmions in two di erent regimes of the parameter space. Sparse skyrmions emerge at nite temperatures as excitations of the ferromagnetic phase. Further, the skyrmion states are characterized as topological metals via explicit calculations of Bott index and Hall conductivity. Local density of states (LDOS) display characteristic oscillations arising from a combination of con nement e ect and gauge- eld induced Landau level physics. These unique features serve as testable predictions for the presence of the new mechanism of skyrmion formation in real materials. The discovery of a new mechanism based on two celebrated physics concepts not only lls a major conceptual void in the current understanding of skyrmions and antiskyrmions in metals, but also opens a new route for tuning the size, density and stability of skyrmions in magnetic metals. We also emphasize the importance of a consistent treatment of spin-orbit coupling for calculating electronic properties of metals hosting unconventional magnetic textures such as skyrmions. Finally, we provide a clear understanding of how Neel-type skyrmions, Bloch-type skyrmions and the corresponding antiskyrmions are related with one another within a simple lattice model. We also emphasize the role played by electron itineracy in decid- ing the type of skyrmion textures in a metal. These features are completely missed in a spin-only model written without reference to a starting microscopic model.

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