Jacobi Elliptic Functions describe a large class of 1D domain walls in thin infinite slabs.

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The understanding of energy minimizing magnetization configurations is of essential importance for many technological applications of magnetism because systems will spend most of their time in the vicinity of energy minima. Therefore, device designers must be able to predict and identify these configurations. Micromagnetic software has become an invaluable tool for this purpose.

However, the problem is usually not amenable to an analytical solution and the ubiquitousness of advanced computational tools in micromagnetism leads investigators directly into numerics. Hence, it has become common practice to dismiss the question of whether analytical solutions exist to any given problem and many studies stop at the simulator's output. This is unfortunate since analytical results provide further points of access to investigate magnetic systems.

In this work we will describe how Jacobi Elliptic Functions can be used to describe a large class of 1D-dimensional magnetization profiles. To illustrate their use, we will investigate ferromagnetic ribbons with perpendicular anisotropy (PMA). Ribbons are infinitely long and extremely thin structures with moderate width (as compared to the ferromagnetic exchange length). This type of device is important because they can easily be manufactured using a variety of techniques, such as lateral modification of magnetic properties by ion bombardment.

We will show how the number of micromagnetic stable states available to ribbons increases with width in discrete steps. Limiting cases of the Jacobi-Elliptic function include the known profiles of Neel walls for very wide ribbons. A finite interfacial Dzyaloshinskii-Moriya effect causes an energy decrease of non-uniform profiles and forces a magnetization tilt at the ribbon's edge. These effects can readily be understood using Jacobi elliptic functions to describe magnetic textures.

Our hope is that this work illustrates the potential of these functions in a non intimidating way so that they become more widely exploited by the magnetism community.

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