A Fibre Bundle Approach to the Description of the Symmetry of Magnetic Structures in a 6-dimensional Space

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We consider the magnetic symmetry groups in terms of the fibre bundles. To describe magnetic symmetry one needs a 6-dimensional space $\mathbf{E_6}$. This space has the structure of the **fibre bundle** with $\mathbf{R_3}$ as a **base space**, and a 3-dimensional vector space $\mathbf{V_3}$ as a **fibre**. $\mathbf{R_3}$ is the position space of the magnetic structure, while $\mathbf{V_3}$ is spanned by the orthogonal unit vectors $\mathbf{e_1}$, $\mathbf{e_2}$, $\mathbf{e_3}$ and is the space of the magnetization vector. In the simplest case the space $\mathbf{E_6}$ becomes the Cartesian product of the $\mathbf{R_3}$ and $\mathbf{V_3}$. In this formalism one can describe a magnetic structure as a certain subspace **S** of $\mathbf{E_6}$. The subspace **S** in terms of the fibre bundles is called the **section of $\mathbf{E_6}$**. Therefore the corresponding magnetic symmetry group becomes a symmetry group of **S**. In this case the problem of formulating the different magnetic symmetry groups consists in searching the corresponding symmetry groups of **S**. These symmetry groups are defined as groups, which conserve the unique structure defined by the magnetization vector. The magnetic symmetry group in this approach is the **structure group of the bundle $\mathbf{E_6}$.** To illustrate the above approach a ferromagnetic, an antiferromagnetic and both different spiral magnetic structures and spin waves are considered. This approach can serve for the determination of all the other magnetic symmetry groups as well as for the determination of the symmetry groups of all the other aperiodic structures (like the modulated nonmagnetic structures, quasicrystals etc.).

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