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# From $\mu$SR spectra to the magnetic interaction energy parameters: the MnSi helimagnet as a test case

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For several decades the intermetallic compound MnSi has fascinated the community for different aspects of its physical and magnetic properties. Among these properties is the exotic temperature-magnetic field phase diagram. While this diagram was first established in the 1970s, the exact nature of one of the phases was only identified in 2009 as a lattice of magnetic skyrmions, i.e. a topological magnetic texture.
In this contribution we present recent developments in the interpretation of the muon response of MnSi in the helimagnetic and conical phases, respectively observed in zero and finite fields. These developments are based on a computation of the asymmetry spectrum in terms of the incommensurate magnetic structure parameters and the muon site and coupling.

In a first step we show the magnitude $m$ of the magnetic moment in the helical phase, the temperature dependence of which has attracted little attention in the literature, to decay as $T^2$ from its low temperature value. We interpret this decay as the result of spin waves excitations. The slope of $m$ vs $T^2$ determines the two dominant energy contributions in the traditional expression used for magnetic energy of the system.

In a second step, instead of the previously mentioned continuous field model, we consider a microscopic model for the energy, accounting for the presence of four magnetic Mn sites in the crystal unit cell and the symmetry elements of the $P2_13$ space group in which MnSi crystallizes. The minimization of the energy is obtained for structures that somewhat deviate from the regular helical and conical phases. This result is consistently confirmed by fits to the asymmetry spectra which provide a quantitative determination of the microscopic model parameters. Directions for future developments are presented.

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