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Theory of the helical spin crystals

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Recent experiments in the "partial order" regime at high pressure in MnSi quite intriguingly suggest diffuse spin correlations and slow dynamics in a pure crystalline metal. As a starting point for a theoretical description of this phase, we are investigating the nature of its dominant spin correlations. Particularly, the observed location of maximal neutron scattering intensity around $\langle 110 \rangle$ is difficult to explain in terms of fluctuating helical spin-density waves alone. We therefore investigate helical spin crystals. These are magnetic structures obtained by superimposing distinct spin spirals, via a process reminiscent of crystallization. Based on a phenomenological Landau description, we identify which spin crystal structures may be energetically stabilized and study their properties. One of these states, a bcc spin crystal, is compatible with existing data on MnSi from neutron scattering and magnetic field studies. It also shows new and interesting phenomena, such as symmetry stabilized topological textures, missing higher order Bragg reflections and an octupolar order parameter. Possible routes towards "partial order," which requires the destruction of long-range order by some mechanism, will be briefly discussed.