Non-centrosymmetric cubic magnets

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In non-centrosymmetric cubic magnets helical structure is a result of weak Dzyaloshinskii-Moriya interaction (DMI). Due to the cubic symmetry the DMI can not fix direction of the helix axis $\mathbf{k}$ More weaker interactions such as anisotropic exchange (AE) and cubic anisotropy (CA) become important and magnetic system is very sensitive to magnetic field and pressure. The AE fixes direction of $\mathbf{k}$ and the CA gives contribution to the spin-wave gap. Classical energy depends on the magnetic field along $\mathbf{k}$ only. At critical field $g\mu_B H_c = Ak^2$ where A is the spin-wave stiffness ferromagnetic spin configuration appears. At $H = 0$ the spin-wave spectrum is strongly anisotropic: at $q < k$ the spin-wave energy is proportional q and q^2 for excitations with the wave vector $\mathbf{q}$ along and perpendicular to $\mathbf{k}$ respectively. It is a result of the DMI which breaks the total spin conservation law and gives rise to umklapp interaction between the spin waves with $\mathbf{q}$ and $\mathbf{q} \pm \mathbf{k}$ with different energies. In ferromagnetic state ($H > H_c$) this anisotropy disappears. The field component $H_\perp$ perpendicular to $\mathbf{k}$ turns the helix axis to the direction of the field in agreement with experiment [1], [2]. This rotation begins at $g\mu_B H_\perp \sim \Delta$ where Δ is the spin-wave gap. The gap appears due to the spin-wave interaction and the cubic anisotropy. The former contribution to Δ^2 is positive but the latter may has an arbitrary sign. The long-range helical order is stable if Δ^2 is positive. Otherwise the system is in the spin liquid state with strong chiral fluctuations which are a result of the DMI and can be studied by polarized neutrons. Relative change of these two contributions to Δ^2 may be a cause for the transition to non-magnetic state at high pressure [3] and [4].

There are several problems which has to be studied using neutron scattering. We point here few of them: investigation of the umklapp anisotropy of the spin-waves and its disappearance at $H > H_c$; chiral scattering in zero field and in ferromagnetic state. In the last case the spin-wave scattering must be maximal at $\mathbf{q} = \pm\mathbf{k}$.

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