Staggered Dzyaloshinskii-Moriya interaction in altermagnets

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The Dzyaloshinskii-Moriya interaction (DMI) has explained successfully the weak ferromagnetism in *some* centrosymmetric antiferromagnets. However, in the last years, it was generally claimed that the DMI is not effective in centrosymmetric systems. We reconciled these views by separating the conventional antiferromagnets and altermagnets.

Altermagnets represent collinear antiferromagnetic compounds with spin-up and spin-down sublattices connected only by mirror and roto-translational symmetries. Consequently, the system shows even-parity wave spin order in the k-space lifting the Kramer's degeneracy in the non-relativistic band structure.[1,2]

We emphasize that the DMI can create weak ferromagnetism in centrosymmetric altermagnets while it is not effective in centrosymmetric conventional antiferromagnets. Additionally, DMI can create weak ferromagnetism or weak ferrimagnetism in noncentrosymmetric altermagnets.

Once the spin-orbit coupling is included in an altermagnetic system without time-reversal symmetry, the components of spin moments of the two sublattices along the Néel vector are antiparallel but the other two spin components orthogonal to the Néel vector can be null, parallel or antiparallel for centrosymmetric systems. For noncentrosymmetric systems, we can have different bands showing parallel or antiparallel spin components resulting in weak ferrimagnetism. The altermagnetic compounds can be divided into classes based on the weak ferromagnetism or weak ferrimagnetism properties. In the case of weak ferromagnetism, the Hall vector is orthogonal to the Néel vector while in the case of weak ferrimagnetism the Hall vector has a component parallel to the Néel vector too. We find a sign change of the magnetization, and possibly of the anomalous Hall effect, as a function of the band filling and Néel vector. We describe the dependence of the weak ferromagnetism from the charge doping and electric field. The weak ferromagnetism and weak ferrimagnetism induced by the staggered DMI is a property exclusively of the altermagnets, not present in either ferromagnets or conventional antiferromagnets.[3,4]

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[3] **C. Autieri, R. M. Sattigeri**, **G. Cuono**, **A. Fakhredine**. https://arxiv.org/abs/2312.07678 (2024)
[4] **C. Autieri**, Nature **626**, 482 (2024).