## Dzyaloshinskii-Moriya interaction $E_{ij} = \overrightarrow{D_{ij}} . (\overrightarrow{S_i} \times \overrightarrow{S_j})$ Dzyaloshinskii 1957

**Due to spin-orbit coupling**

$\overrightarrow{D_{ij}} = -\overrightarrow{D_{ji}}$ **in order to satisfy $E_{ij} = - E_{ji}$**

**In general small: D/J≈ 0.1**

**Non zero only if there is no inversion center between i and j:**

- **near surfaces**
- **in magnetic molecules**
- **in some crystal structures**

**Direction of D-vector determined by some rules (Moriya rules)- often ⊥ i-j**

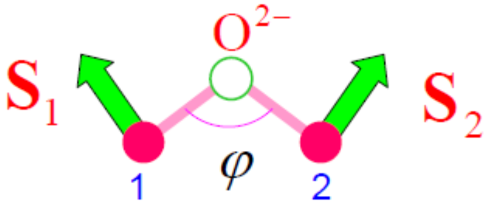
**Chiral interaction $E(S_i, S_j) \neq E(S_j, S_i)$**

**Favors non-colinear, sometimes helical structures (MnSi)**

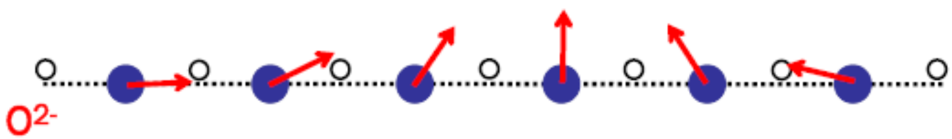
**Weak ferromagnetism**


**∝ D/J**

**Inverse Dzyaloshinskii-Moriya interaction** $E_{DM} = -\mathbf{D}_{12} \cdot [\mathbf{S}_1 \times \mathbf{S}_2]$




**DM interaction is one of the main mechanism proposed for multiferroics**




**Helicoidal order + weak ferroelectricity**

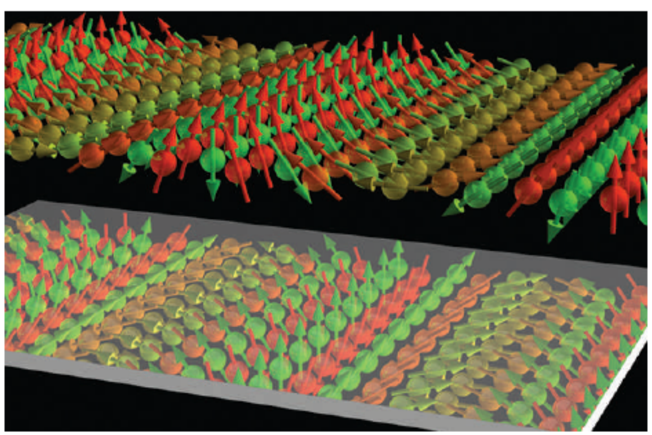


**Figure 1 | Handy magnet.** Bode *et al.*[1] report that the spins of a layer of manganese atoms on a tungsten substrate develop magnetic order in the form of a spiral rolling along the surface. The spiral has a unique turning sense, or chirality, with respect to the surface.

**Plays an important role at surfaces**

*1 Mn layer on tungsten*