Representation analysis of magnetic structures: « time inversion» or « reality of the magnetic moments» ?

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The "time inversion" operator, acting on a magnetic structure, reverses all the moments of this structure. The quadratic free energy resulting from the interactions between the magnetic moments is invariant under this operation. There exists a confusion about how and how useful it is to introduce this operator in the representation analysis of the magnetic structures. Actually, there are two ways to define the "time inversion" operator: a linear operator and an antilinear one. We shall show that the introduction of the linear operator does not bring extra information, but considering the antilinear operator brings more restrictions on the possible magnetic structures.

Because it is antilinear, this operator imposes the use of the corepresentations instead of representations in group theory, an algebra developed by Wigner for the "time reversal operator in quantum mechanics", an operator which is always antilinear. What makes the wealth of this process is not the sign change resulting from the time inversion, but the association in the same irreducible corepresentations of propagation vector $-\mathbf{k}$ and propagation vector $\mathbf{k}$.

One can the ask whether it is really necessary to invoke time inversion to associate propagation vector $-\mathbf{k}$ and propagation vector $\mathbf{k}$. Magnetic moments being real, the quadratic free energy is clearly invariant under operation conjugation, which is obviously an antilinear operator. Introducing this operator in the representation analysis of the magnetic structures imposes the fruitful use of the Wigner algebra. We show this way that what brings new information in the representation analysis of the magnetic structure is the consideration of the reality of the magnetic moments, and not the invariance of their free energy when reversing all the magnetic moments.