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Thermoelectric transport properties in magnetically ordered materials

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Transport properties of a material like electric or heat conductivity are generally not the same in all directions. The direction dependence can be described by a tensor, the form of which depends on the point group of the material. The Peltier and Seebeck effects describe the interaction between thermal and electric transport properties. If a magnetic field is applied to the material, further effects appear, named after Hall, Righi-Leduc, Nernst and Ettingshausen. These effects exist in all materials, also in dia- and paramagnetic ones, where the spins are not ordered.
In case of magnetically ordered materials, one has to deal also with the spontaneous Hall, Righi-Leduc, Nernst and Ettingshausen effects (which occur without applying a magnetic field) and with the change of these effects in a magnetic field. The effects are determined by tensors invariant under space inversion but changing sign under time inversion, called "magnetic tensors", which do not vanish only for materials belonging to at most 69 of the 122 space-time point groups.

Making use of the Onsager relations the form of the corresponding tensors has been determined in [1] for all 122 space-time point groups and in [2] for the 21 limit point groups (Curie groups). The results are presented in Nye notation, which immediately shows how many tensor components are independent, which ones are zero and how the non-zero components are related.
The results triggered a recent extension of the information offered on the Bilbao crystallographic server [3].

[1] H. Grimmer (2017) Acta Crystallogr. A73, 333-345.
[2] H. Grimmer (2019) Acta Crystallogr. A75, 409.
[3] S. V. Gallego, J. Etxebarria, L. Elcoro, E. S. Tascib and J. M. Perez-Mato (2018) Acta Crystallogr. A75, 438–447.

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