Stuttgarter Physikalisches Kolloquium

Max-Planck-Institut für Intelligente Systeme
Max-Planck-Institut für Festkörperforschung
Fachbereich Physik, Universität Stuttgart

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Stuttgarter Max-Planck-Institute, Heisenbergstraße 1, 70569 Stuttgart-Büsnau

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Magnetocaloric Effect: From Energy Efficient Refrigeration to Fundamental Studies of Phase Transitions

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Abstract

The magnetocaloric effect, that is, the reversible temperature change experienced by a magnetic material upon the application or removal of a magnetic field, has become a topic of increasing research interest due to its potential applications in refrigeration at ambient temperature that is energy efficient and environmentally friendly. From a technological point of view, the improvement of magnetic refrigeration systems can have a notable impact on society: a large fraction of the electricity consumed in residential and commercial markets is used for temperature and climate control. From the point of view of magnetic materials, research on this topic mainly focuses on the discovery of new materials with lower cost and enhanced performance. In addition, the characterization of the magnetocaloric effect can be used for more fundamental studies of the characteristics of phase transitions.

I will cover an overview of the phenomenon and a classification of the most relevant families of alloys and compounds. I will analyze possible limitations for the optimal performance of the materials in magnetic refrigerators, including hysteretic response and cyclability. Regarding phase transitions, I will present a new method to quantitatively determine the order of thermomagnetic phase transitions using the field dependence of the magnetic entropy change. For second-order phase transition materials, I will show that critical exponents can be determined using the magnetocaloric effect even in cases where the usual methods are not applicable. In the case of first-order phase transitions, more details about their hysteretic response can be obtained using T-FORC.