INSTITUTE SEMINAR

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Speaker:

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Title:

Geometrically Frustrated Magnets for Solid State Magnetic Cooling

Abstract:

Technologies which require low operating temperatures include many with medical applications such as magnetic resonance imaging (MRI) scanners. At present the most common way of achieving low temperatures is through the use of the cryogenic gases. In the case of cooling using helium, this is problematic due to the limited and volatile supply. A number of alternatives to cooling using cryogenic liquids exist including thermoelectric, electrocaloric and magnetic cooling.

Magnetic cooling relies on the magnetocaloric effect (MCE) where a change in the entropy on application of a magnetic field drives cooling during an adiabatic demagnetisation process. At low temperatures magnetic cooling is currently achieved using dilute magnetic salts with low magnetic ordering temperature. I will present recent work exploring complex oxides for solid state magnetic cooling applications. These have the advantage of being stable for a wide range of compositions, highly tuneable through chemical doping and have a high density of magnetic cations. We focus on geometrically frustrated magnets (GFMs) in which the magnetic ordering is supressed to an order(s) of magnitude below the Weiss temperature, θ, by the frustration in the magnetic lattice. By coupling this with the low θ observed in lanthanide oxides the magnetic ordering is supressed to $T < 1$ K. I will demonstrate, using the $Gd_3Ga_{5-x}Al_xO_{12}$ ($0 \leq x \leq 5$) garnet solid solution, the role that both the crystal and the magnetic structure have on the MCE. Preliminary results exploring alternative materials and mechanisms for solid state magnetic cooling will also be discussed.
