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Interplay between trimerization, ferroelectric, and magnetic order in the hexagonal manganites[1]

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The hexagonal manganites h-$RMnO_3$ with R = Sc, Y, In, Dy – Lu are a model system for multiferroics with pronounced magnetoelectric effects in which the magnetic and ferroelectric order emerge independently (so-called split-order-parameter or type-I multiferroics). In spite of many years of intense investigations the system never seizes to surprise us with novel, unexpected manifestations of its five-fold long-range order (antiferrodistortive, ferroelectric, antiferromagnetic Mn order, and rare-earth order on the 2a and 4b sites). Here I will discuss several such examples: (i) "Incompatible" magnetic order of the Mn and rare-earth sublattices according to different symmetry representations in combination with triggered ordering at the 4b site. (ii) The it absence of ferroelectric order in h-$InMnO_3$ down to low temperatures in spite of its apparent similarities to, in particular, h-$YMnO_3$. (iii) Observation of a direct and rigid coupling of the ferroelectric to the antiferrodistortive order in annealing experiments at 1300 K. In summary, all these experiments allow us to present a comprehensive model for the microscopic origin of the ferroelectric and the multiple magnetic (re-) ordering in this important group of compounds.

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