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Electronically soft matter

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The phenomenon of colossal magnetoresistance in manganites is generally understood to be a result of competition between crystal phases with different electronic, magnetic, and structural order; a competition which can be strong enough to cause phase separation between metallic ferromagnet and insulating charge modulated states. Nevertheless, closer inspection of phase diagrams in many manganites reveals complex phases where the two order parameters of magnetism and charge modulation unexpectedly coexist. I will discuss how such experiments can be naturally explained within a phenomenological Ginzburg-Landau theory, where magnetic and charge modulation coexist in new thermodynamic phases, structured on the nanoscale [1]. It seems possible that this is a general phenomenon, which commonly pre-empts first-order transitions. Remarkably, it is also found that the charge modulated insulating states seem to be better regarded as charge density waves instead of the expected strongly localised striped phases [2, 3]. The disjunction of the phenomenology versus the expectations from microscopic models and measurements raises some conundrums about the treatment of strong electron-phonon interactions in oxides.

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