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Title: An experimental history of superspin glasses: from dipolar-driven nanogranular systems to superexchange-driven dense compacts

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Abstract:

For about three decades, the superspin glass (SSG) behavior of sufficiently concentrated nanoparticle systems has been understood in terms of dipolar interactions. Very recently, however, we have found experimental evidence for the interparticle propagation of superexchange interactions and their dominance over magnetostatic interactions in dense assemblies of Fe oxide nanoparticles presenting the same SSG behavior. We have investigated a series of randomly compacted dried colloidal maghemite particles (5 nm in diameter), in which the oleic acid surfactant has been removed to varying degrees. Our results show that coercivity and the collective freezing temperature are essentially governed by the density of particle–particle contacts, as estimated through SAXS data modeling. Intercalated oxygen at oriented {111} facets likely constitutes the primary superexchange pathway. High intraparticle structural uniformity (i.e., absence of surface spin disorder, as concluded by the lack of any exchange-bias effect) appears to be key for enabling interparticle superexchange. The resulting magnetic behavior offers a new perspective on the broader problem of particle aggregation.