The Bigger The Better? - Updates on the Statistical Limits of Nano-Palaeomagnetic Works and (sub)millimeter Samples

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A recent trend in paleomagnetism is the study of samples of ever decreasing sizes, going down to (sub)millimeter scales and even microscopic scales (“nanopaleomagnetism”). These include studies of single-silicate-crystals, microscopic magnetic imaging of the cloudy zones in Iron meteorites, and recently even the determination of individual magnetic remanence carriers. As single-crystal and nanopalaeomagnetic methods are getting more adopted, it is getting increasingly important to assess the statistical reliability with which such small samples can record remanences from a physical perspective. We previously proposed a benchmark to assess small-scale samples of randomly oriented non-interacting single-domain (SD) particles and found that in most cases, the number of magnetic particles a sample must contain lies in the order of tens to hundreds of millions – or equivalently NRM strengths of the order of $10^{-12} \text{ Am}^2$. In this talk, we present how this benchmark can be used as a simple yet indispensable tool to assess whether or not (sub)millimeter-size and nanopalaeomagnetic samples are able to statistically reliably record palaeomagnetic fields. Moreover, this talk will provide an outlook into future limitations but also opportunities of the statistical physics nature of microscopic magnetic particle systems. It will explore if multi-domain particles should ever be considered statistically reliable recorders, how interactions in SD particle clusters might affect statistical reliability, and will review the various challenges that Iron meteorites pose as a remanence recorder.