Comment on "Thermoinduced magnetization in nanoparticles of antiferromagnetic materials" - Reply

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Mørup and Frandsen Reply: In their Comment Silva *et al.* [1] point out that an apparent increase of the magnetic moment of antiferromagnetic nanoparticles with increasing temperature can be explained by the moment distribution. Thus the thermoinduced magnetization, described in our Letter [2], may not be the only reason for the anomalous temperature dependence of the magnetic moment, which has been found in several experimental studies.

The experimental data in earlier studies of the magnetization of antiferromagnetic nanoparticles have in most cases been analyzed with rather simple models like a single Langevin function in combination with a linear term. Therefore, we agree that there may be other contributions to the temperature dependence of the estimated magnetic moments, including effects related to the distribution of magnetic moments as suggested by Silva *et al.* [1]. The magnetic anisotropy can also give rise to deviations from a simple Langevin behavior [3], and this has also been ignored in most studies. In a detailed analysis it must also be taken into account that the (sublattice) magnetization of nanoparticles decreases with increasing temperature in a way that may differ from the bulk behavior.

In our Letter [2] we proposed a model for thermoinduced magnetization and we fitted data for the temperature dependence of the magnetic moment, obtained in previous experimental studies [4,5], with the model. We found surprisingly good agreement between the data and the theoretical model, without taking into account that there might be contributions to the estimated magnetic moments due to other mechanisms. Thus thermoinduced magnetization can explain the main features of the experimental data. Comparing data for the temperature dependence of magnetic moments, obtained without taking into account the moment distribution, the results are quite similar for ferrihydrite [4], with a broad size distribution, and for ferritin [5] with a narrow size distribution [6]. Although there may not be a simple relationship between particle size and magnetic moment these results suggest that the size distribution is not the main reason for the temperature dependence of the magnetic moments. However, detailed studies of well-characterized samples are needed to clarify the relative importance of the different contributions to the apparent magnetic moment of antiferromagnetic particles.

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