Proton relaxation induced by iron oxide superparamagnetic particles: experiments and simulations

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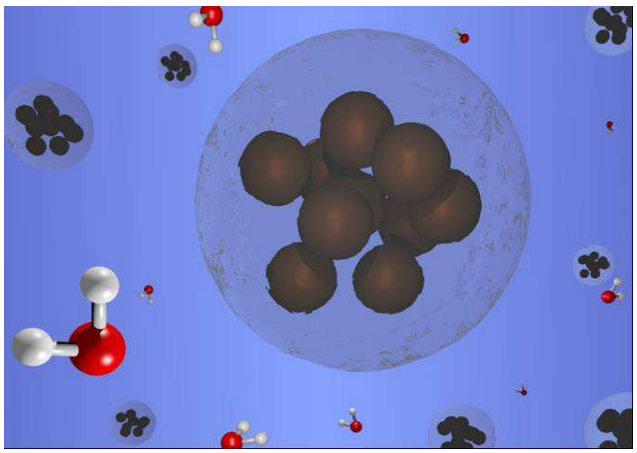
Magnetic Resonance Imaging (MRI) is a major clinical imaging technique. It provides contrasted images of the body with a good resolution. For some specific applications, contrast agents composed of iron oxide superparamagnetic nanoparticles are used[1] because they considerably shorten the water proton relaxation times, T_1 and T_2.



Sketch of the relaxation process

The efficiency of magnetic particles for biomedical applications is closely related to their physico-chemical properties, as the size, the structure and the magnetization. Different theoretical models allow the prediction of their NMR relaxation properties, once their size, magnetization and clustering stage are known. We will first present the confrontation between different relaxation models with experimental relaxation results[2] on various particles, proving the adequacy of these models. However for some sizes and magnetizations, the theoretical models are no more valid and computer simulations must be used to study the efficiency of the potential contrast agents. In the second part of our talk, we will present some of these simulation results[3]. This will help to find the optimal particle and cluster parameters for a maximum efficiency of the contrast agent.

1. Gossuin Y., Gillis P., Hocq A., Vuong Q. L., Roch A. MR relaxation properties of superparamagnetic particles. Wiley Interdisciplinary Reviews – Nanomed. Nanobiotechnol. 1 : 299-310 (2009).

2. Gossuin, Y., Berret, J. F., Vuong, Q. L., Fresnais, J., Sandre, O. Universal Scaling Law to Predict the Efficiency of Magnetic Nanoparticles as MRI T2-Contrast Agents, Submitted to Advanced Functional Materials.

3. Vuong, Q. L., Gillis, P., Gossuin, Y. Monte Carlo simulation and theory of proton NMR transverse relaxation induced by aggregation of magnetic particles used as MRI contrast agents, J. Magn. Reson. 212, 139–148 (2011).