

# Tuning the relaxation rates of dual mode $T_1/T_2$ nanoparticle contrast agents: a study into the ideal system

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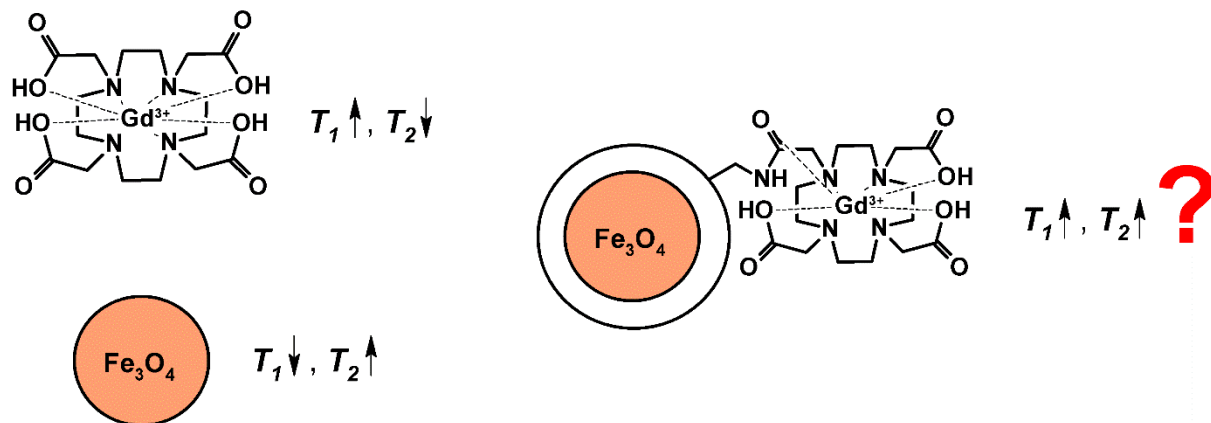
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## ABSTRACT:



Magnetic resonance imaging (MRI) is an excellent imaging modality.<sup>1</sup> However, the low sensitivity of the technique poses a challenge to achieving an accurate image of function at the molecular level. To overcome this, contrast agents are used; typically gadolinium based agents for  $T_1$  weighted imaging, or iron oxide based agents for  $T_2$  imaging. Traditionally, only one imaging mode is used per diagnosis although several physiological situations are known to interfere with the signal induced by the contrast agents in each individual imaging mode acquisition. Recently, the combination of both  $T_1$  and  $T_2$  imaging capabilities into a single platform has emerged as a tool to reduce uncertainties in MR image analysis.<sup>2</sup> To date, contradicting reports on the effect on the contrast of the coupling of a  $T_1$  and  $T_2$  agent have hampered the application of these specialised probes.<sup>3</sup> Herein, we present a systematic experimental study on a range of gadolinium-labelled magnetite nanoparticles envisioned to bring some light into the mechanism of interaction between  $T_1$  and  $T_2$  components, and advance towards the design of efficient (dual)  $T_1$  and  $T_2$  MRI probes. Unexpected behaviours observed in

some of the constructs will be discussed. In this study, we demonstrate that the relaxivity of such multimodal probes can be rationally tuned to obtain unmatched potentials in MR imaging, exemplified by preparation of the magnetite-based nanoparticle with the highest  $T_2$  relaxivity described to date.

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