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HYMN –A novel unified toolbox for in-situ magnetic hyperthermia experiments using neutron scattering

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One of the most promising cases of magnetic hyperthermia is using magnetic nanoparticles (MNPs) in cancer therapy. In this treatment, MNPs are immersed into tumours and, by heating with external magnetic fields, typically 100-900 kHz, destroy cancer cells. Since it is a clinical application, optimising field parameters and the heating power is crucial to maintain both safety and high efficiency. Safety dictates an upper limit of the applied magnetic field. Hence, for a successful application, the heating power needs to be improved by optimising the MNP structure. Moreover, recent studies have shown a massive increase in magnetic heating by the excitation of transversal spin modes in MNPs in the low GHz range. An ideal tool for characterising such MNPs is small angle neutron scattering (SANS), with the extended functionality provided by the MIEZE technique. Our ERUM-Pro HYMN project aims to develop a novel, unified experimental and computational toolbox for in-situ magnetic hyperthermia experiments under clinical conditions, utilising the SANS and MIEZE-SANS techniques combined with nanomagnetic simulations. This will be achieved by developing two custom-made setups for operation in the 100-450 kHz (up to 30 mT) and 0.5-4 GHz (up to 2 mT) range. We present the first SAXS and SANS results, where we used in-situ RF heating at 450 kHz to examine magnetite nanocubes with 12, 34 and 53 nm sizes. For these samples, we have found promising indications of dynamic structure formation.

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