Using low-frequency magnetic field and magnetic nanoparticles for the destruction of cancer cells: setups, theory and experiments

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Scientific context

Magnetic nanoparticles (MNPs) have currently many applications in biomedicine : they are used for imaging, to improve gene transfection, for bio-separation and for tissue engineering [1]. With respect to cancer therapy, different ways to kill tumour cells using magnetic nano-objects have been reported. The most studied so far is magnetic hyperthermia, which consists in rising the temperature of a tumour using MNPs injected intra-tumorly. MNP heating is induced by the application of high-frequency magnetic fields. More recently, the destruction of cell membranes using the motion of magnetic disks bound to them using slowly varying magnetic fields have been reported [3,4]. Since then, several groups have shown that MNPs can also be used to induce cell death using such low-frequency magnetic fields [5-11]. The present post-doc aims at working on this latter approach.

Objectives

The objectives of the present post-doc are manifold. First, several types of setups generating low-frequency rotating magnetic field will be developed, adapted to *in vitro* experiments. These setups should be built and tested in collaboration with our biologist collaborators. Second, our group has recently developed kinetic Monte-Carlo simulations permitting to calculate the torque undergone by assemblies of MNPs under rotating magnetic fields [12]. These theoretical studies will be pursued. Third, we aim at verifying experimentally the prediction of these simulations on experimental systems. A PPMS module permitting torque measurements will be bought and the protocol suited to perform torque measurements on assemblies of MNPs developed. We aimed at performing a theory/experiments comparison study on the torque properties of an assembly of MNPs. Finally, a part of the project will consist in performing magnetic measurements in collaboration with the biologists and chemists working on this project to dose MNPs inside cells or characterize synthesized MNPS.

Partners involved and supervision

The candidate will be located in the "Nanomagnetism" group of the LPCNO, Toulouse. The group has developed original approaches to study the magnetic and hyperthermia properties of MNPs, has a strong experience in the development of custom setups to generate magnetic field of various frequency and amplitudes, and has developed theoretical tools to calculate the dynamic magnetic properties of MNPs. The candidate will collaborate with the "Receptors and therapeutic targeting of cancer" group of the LPCNO, which perform cell death experiments, and with the "Laboratory for vascular translational science" (Paris), which synthesize MNPs with controlled size, shape and coating. In addition, collaboration with the "Nanostructure and organometallic chemistry" group of the LPCNO, which synthesize high-quality metallic MNPs, will be possible.

The candidate will be supervised by Julian Carrey, and will interact with other researchers of the groups (T. Blon, M. Respaud) for torque measurements.

Candidate

The candidate should be a physicist with a strong affinity with experiments and a good knowledge of magnetism. A previous experience using numerical simulations and/or the knowledge of C language would be appreciated. Finally, the candidate will have to interact with chemists and biologists, so a strong scientific curiosity, an open mind and good communication skills will be useful.

Administrative aspects

The funding is for a duration of three years. It could be cut in renewable contracts of one year. The post-doc contract should start the 1st of November, 2017.

Application

Please send resume, publication list and motivation letter to Julian Carrey (julian.carrey@insa-toulouse.fr) before September, 15th, 2017.

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