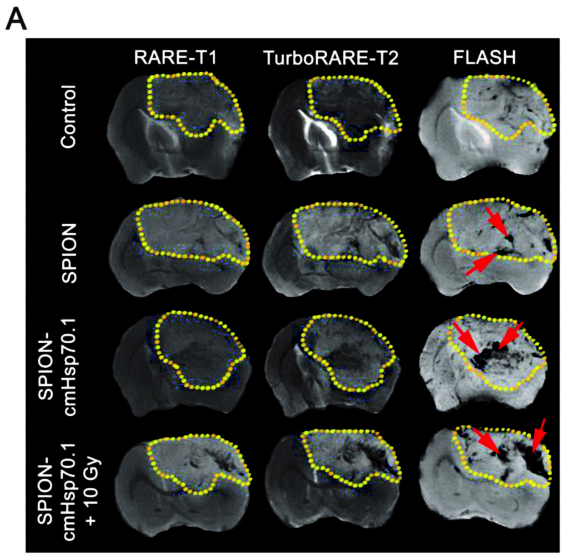
Simulation of Nuclear Magnetic Relaxation Induced by Superparamagnetic Nanoparticles trapped in a biological tissue : introduction

- Superparamagnetic Iron Oxide Nanoparticles (SPIONs) yield negative T_2 contrast in MRI.
- SPION-induced NMR relaxation relies on diffusion of water protons in field inhomogeneities.
- In organic tissues, water diffusion is constrained by cell membranes.
- Hard to take into account theoretically → numerical simulation

- Monte Carlo algorithm :
  - A random proton is allowed to move in the space.
  - If it meets a membrane, the probability to cross it is $p = \frac{6P}{v_i} = P\sqrt{\frac{6\tau}{D}}$
  - The magnetic field at the new position is computed
  - The corresponding dephasing of the proton's magnetic moment is computed and translated in a reorientation of the magnetic moment.
  - The total magnetic moment of the sample as a function of time is fitted to a decaying exponential and the time constant T_2 is extracted.



Source : Shevtsov M.A. et al., *Ionizing radiation improves glioma-specific targeting of superparamagnetic iron oxide nanoparticles conjugated with cmHsp70.1 monoclonal antibodies (SPION–cmHsp70.1)*, ***Nanoscale***, 2015,**7**, 20652-20664, **DOI**: 10.1039/C5NR06521F

Main finding : the more inhomogeneous the particle disposition in the tissue, the more the membrane permeability influences T2.