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Hyperpolarizing 13C spins by dynamic nuclear polarization for MRI applications

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Hyperpolarization by dynamic nuclear polarization (DNP) can increase magnetic resonance (MR) sensitivity by several orders of magnitude offering the opportunity to perform real-time in vivo MR imaging (MRI) experiments [1,2]. Numerous preclinical applications have demonstrated the enormous potential of hyperpolarized 13C MRI for in vivo metabolic imaging and several research hospitals are currently performing studies on patients [3,4].

Unpaired electron spins are used as polarizing agents to increase the nuclear spin polarization of 13C nuclei located on molecules that can be injected to follow metabolic processes. To take advantage of this technology, a DNP polarizer has to be placed in the vicinity of an MRI scanner and the hyperpolarized 13C-labeled metabolic substrates need to be produced a minute or less prior to the injection. This delay as well as the required synchronization between the production and the injection limits the type and number of in vivo metabolic imaging experiments that can be done.

In this lecture, I will present novel methods that open new opportunities to perform hyperpolarized 13C MRI through the circumvention of some of the limitations of the current hyperpolarization technology. In particular, I will show how DNP methods based on non-persistent photoinduced radicals can be designed to dramatically increase the lifetime of the hyperpolarized state by increasing the 13C longitudinal relaxation time of frozen 13C-molecules [5-7].

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Primary author: Dr COMMENT, Arnaud (University of Cambridge)

Presenter: Dr COMMENT, Arnaud (University of Cambridge)

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