

Chemistry of Contrast Media

Small Molecules

Hyperpolarised Probes

Damian Tyler

University of Oxford, UK

Learning Objectives:

- To understand the general principles of hyperpolarization
- To overview the main techniques used to generate a hyperpolarized state
- To detail how hyperpolarization can be utilized in magnetic resonance imaging experiments
- To review the main areas in which hyperpolarized techniques have been applied

Metabolic imaging, where imaging technology is coupled with metabolic probes to detect disease-specific biomarkers, is transforming our approach to disease detection and treatment. In recent years the development of magnetic resonance imaging (MRI) has provided a valuable new approach for the assessment of tissue structure and function. However, despite the enormous technical developments that have taken place, MRI remains an inherently low sensitivity technique and the low signal levels obtained limit its application for the assessment of metabolism. More recently, the development of a range of techniques, which can be gathered under the umbrella term of 'hyperpolarization', has offered potential solutions to this low sensitivity. Such hyperpolarization methods, including dynamic nuclear polarization (DNP), parahydrogen induced polarization (PHIP) and optical pumping of the noble gases, have been demonstrated to increase the sensitivity of MRI to detect metabolic tracers by more than 10,000-fold, thereby allowing in vivo substrate uptake and metabolism to be measured in real-time and at repeated time-points during disease progression. Various studies have been performed in different pre-clinical models of disease demonstrating unprecedented visualization of the biochemical mechanisms of normal and abnormal metabolism. With the emerging clinical application of hyperpolarized helium and xenon imaging of the human lungs and the recent landmark demonstration that DNP enhanced MRI can be safely applied in humans in the study of prostate cancer, the potential for clinical application of hyperpolarized MRI in the assessment of many different diseases has become a reality.

This talk will provide a general introduction to the principles of hyperpolarization with a detailed overview of the different hyperpolarization techniques and their potential areas of application. The talk will also provide a review of the existing literature, summarizing the key experimental findings and the potential application areas for clinical translation.