Developing parahydrogen hyperpolarization based targeted metabolomics methods and applications

Summary

The aim of the PhD project is to use pH2 hyperpolarization to develop practical NMR detection-based tools to access previously undetectable information below the LoD of regular NMR, including diagnostic biomarkers and drugs. The candidate will work towards adapting pH2 hyperpolarization to biological matrices, including liquid biopsies (blood and urine). He/she will use the pH2 hyperpolarization toolbox to develop practical analytical and diagnostic methods that are not feasible by regular NMR. In other words, the goal is to gain access to previously unobtainable biological information.

Research field:	Chemistry and biotechnology
Supervisors:	Dr. Indrek Reile Dr. Kerti Ausmees
Availability:	This position is available.
Offered by:	National Institute Of Chemical Physics And Biophysics
Application deadline:	Applications are accepted between June 01, 2023 00:00 and June 30, 2023 23:59 (Europe/Zurich)

Description

The NMR group in the National Institute of Chemical Physics and Biophysics (KBFI) in Tallinn, Estonia, has an opening for a PhD position for developing applications for complex (bio)mixtures analysis by parahydrogen hyperpolarization.

NMR analysis of complex biological mixtures (e.g., human biofluids) is challenging due to the limited sensitivity of NMR – a lot of biologically valuable information falls below the NMR limit of detection (LoD). However, more than 1000-fold sensitivity gains have been recently demonstrated with parahydrogen (pH2) hyperpolarization. We have shown that pH2 hyperpolarization allows detection and quantification of sub-micromolar quantities of analytes in a biofluid (urine) [1] and is applicable for metabolomics [2,3] below the usual NMR sensitivity barrier.

The aim of the PhD project is to use pH2 hyperpolarization to develop practical NMR detection-based tools to access previously undetectable information below the LoD of regular NMR, including diagnostic biomarkers and drugs. The candidate will work towards adapting pH2 hyperpolarization to biological matrices, including liquid biopsies (blood and urine). He/she will use the pH2 hyperpolarization toolbox to develop practical analytical and diagnostic methods that are not feasible by regular NMR. In other words, the goal is to gain access to previously unobtainable biological information.

The project is inherently interdisciplinary and will combine our expertise in several chemistry disciplines. The PhD candidate will be exposed to analytical chemistry, NMR spectroscopy, (metal)organic chemistry and biochemistry. Prior exposure to solution NMR and experience in one or more of these disciplines will be seen as a plus.

Research Group:

The PhD candidate will be integrated into the KBFI NMR research group and will be supervised by Dr Indrek Reile and Dr Kerti Ausmees. The group maintains facilities for biological sample handling, sample preparation and organic chemistry. KBFI NMR facilities include 5 spectrometers, based on 200, 360, 500, 600 and 800 MHz magnets – which will be accessible for the project. The laboratory operates in-house developed pH_2 hyperpolarization equipment that allows experimental workflows for which commercial instrumentation is not available.

KBFI is a research only institution and the PhD candidate will be enrolled as an Early Stage Researcher to the nearby Tallinn University of Technology (Taltech). The candidate will have access to Taltech lectures, courses and academic resources at the full PhD curriculum capacity. Funding will be available for 4 years since the start of contract.

Interested candidates should submit their applications via the Taltech application portal. Informal enquires can be directed to indrek.reile@kbfi.ee.

References:

1. Reimets, N.; Ausmees, K.; Vija, S.; Reile, I. Developing Analytical Applications for Parahydrogen Hyperpolarization: Urinary Elimination Pharmacokinetics of Nicotine. *Anal. Chem.* 2021, *93*, 9480–9485, doi:10.1021/acs.analchem.1c01281.
2. Ausmees, K.; Reimets, N.; Reile, I. Parahydrogen hyperpolarization of minimally altered urine samples for sensitivity enhanced NMR metabolomics. *Chem. Commun.* 2022, *58*, 463–466, doi:10.1039/D1CC05665D.
3. Ausmees, K.; Reimets, N.; Reile, I. Understanding Parahydrogen Hyperpolarized Urine Spectra: The Case of Adenosine Derivatives. *Molecules* 2022, *27*, 802, doi:10.3390/molecules27030802.