Ph.D. Candidate

Alexander James Adair

Graduate Academic Unit

Physics

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September 29, 2021

10:30 a.m. (Atlantic)

Virtual Defence

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Examining Board:
Dr. Bruce Balcom (Physics)
Dr. David Keighley (Earth Sciences)
Dr. Tiger Jeans (Mechanical Engineering)
Dr. Ben Newling (Physics) Supervisor

External Examiner: Dr. William Holmes
Institute of Neuroscience & Psychology
The University of Glasgow

The Oral Examination will be chaired by:
Dr. Kevin Englehart, Acting Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2013 – present	Ph.D. candidate, University of New Brunswick
2012	M.Sc. University of New Brunswick
2008	B.Sc. University of New Brunswick

Publications:

A. Adair, S. Richard, and B. Newling, Gas and liquid phase imaging of foam flow using pure phase encode magnetic resonance imaging, Molecules 26 (2021), 28.

A. Adair, B.J. Balcom, and B. Newling, Velocity mapping of fast ows using a lin-early ramped gradient waveform, J. Magn. Reson. 316 (2020), 106754.

A. Adair, F.G. Goora, and B. Newling, Magnetic _eld gradient waveform correction of motion-sensitized SPRITE by pre-equalization, J. Magn. Reson. 298 (2019), 58-63.

A. Adair, I.V. Mastikhin and B. Newling, Motion-sensitized SPRITE measurements of hydrodynamic cavitation in fast pipe ow, Magn. Reson. Imag. 49 (2018), 71-77.

I.V. Mastikhin, A. Arbabi, B. Newling, A. Hamza and **A. Adair**, Magnetic resonance imaging of velocity _elds, the void fraction and gas dynamics in a cavitating liquid, Exp. Fluids 52 (2012), 95-104.

Selected Conference Presentations:

B. Newling*, A-R. Gauthier, **A. Adair**, Purely Phase-Encoded Magnetic Resonance Mapping of Turbulent Anisotropy, Oral presentation at the 72nd Annual Meeting of the APS Division of Fluid Dynamics, November 2019, Seattle, USA.

A. Adair, B. Newling*, Phase Error Correction to Velocity-Encoded Single-Point-Imaging Measurements Using a Sawtooth Gradient Waveform, Oral presentation at the International Conference on Magnetic Resonance Microscopy (ICMRM15), August 2019, Paris, France.

A. Adair*, B. Newling, Comparison of the Gas and Liquid Phase Flow of Foam Using PFG-Readout Velocity Mapping, Poster presentation at the International Conference on Magnetic Resonance Microscopy (ICMRM14), August 2017, Halifax, Canada.

A. Adair*, B. Newling, Liquid and Gas Phase Velocity Measurements of Foam Using Motion-Sensitized SPRITE, Poster presentation at the International Conference on Magnetic Resonance in Porous Media (MRPM13), September 2016, Bologna, Italy.

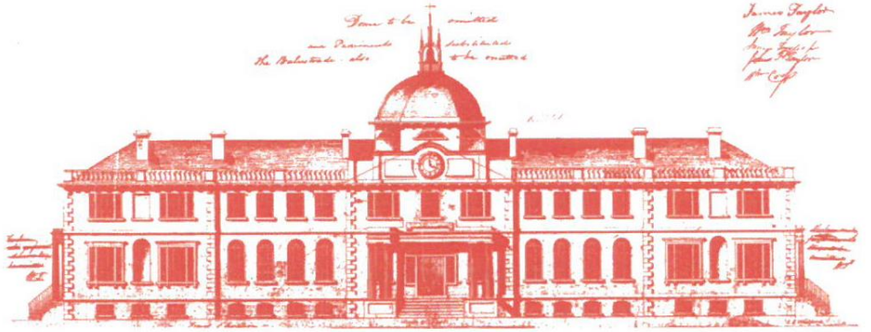
A. Adair, B. Newling*, I. Mastikhin, SPRITE, MRI: A Non-Invasive, Non-Optical Measurement Technique for Multiphase Flows, Oral presentation at the 63rd Canadian Chemical Engineering Conference, October 2013, Fredericton, Canada.

Advancing Pure Phase Encoded MRI Measurement of Flow

Abstract

Magnetic resonance imaging (MRI) is a non-optical and non-invasive measurement technique that employs magnetic field gradients to discriminate nuclei based on position and create images of a sample. A large range of research has been performed using MRI since its inception, but the work in this thesis focuses primarily on the use of MRI to study fluid flow. MRI measurements can be made sensitive to the motion of nuclei by applying magnetic field gradients with appropriate amplitude and duration. A primary concern for motion-sensitized MRI measurements is the difficulty of ensuring that the magnetic field gradients experienced by the sample are as intended. Eddy currents alter the magnetic field gradient waveform experienced by the sample and velocity values that are calculated using the input gradient waveform are incorrect.

This thesis addresses the issue by applying the pre-equalization correction method, which uses measured information about the system impulse response to tailor the input gradient waveform to give a desired output waveform. A pre-equalized version of the motion-sensitized SPRITE measurement was used to create velocity maps of water owing through a pipe constriction and results were contrasted with previous correction techniques. Following this, a new approach was developed that uses a repeating linearly-ramped magnetic field gradient waveform to minimize the effect of eddy currents in a motion-sensitized measurement by greatly reducing the number of gradient-amplitudes switches while still providing accurate velocity information. The linear ramp waveform was used to create velocity maps of water flowing through a pipe constriction and the results were contrasted with those from previous measurement methods. In addition, this thesis demonstrates the application of motion-sensitized SPRITE measurements to the study of foam flow. Foam flow is especially interesting to study because MRI can be made sensitive to the motion of the gas and liquid phases independently. Velocity maps of the gas and liquid phases of foam flow through a pipe constriction were created. Measured velocity maps were compared to simulations of foam flow using a Herschel-Bulkley viscosity model, showing consistent results.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

The University of New Brunswick recognizes that the university sits on traditional Wolastoqey territory. The river that runs right by our university – the St. John River – is also known as Wolastoq, along which live the Wolastoqiyik -- the people of the beautiful and bountiful river.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Alexander James Adair

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY