Ph.D. Candidate

Amy-Rae Gauthier

Graduate Academic Unit

Physics

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July 22, 2022

12:00 p.m. (Atlantic)

Virtual Defence

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Examining Board:
Dr. Igor Mastikhin (Physics)
Dr. Dennis Tokaryk (Physics)
Dr. Sanjeev Seahra (Mathematics & Statistics)
Dr. Ben Newling (Physics) Supervisor

External Examiner: Dr. Dean O. Kuethe
ABQMR Inc.,

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

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2015 – present	Ph.D. candidate, University of New Brunswick
2014	Bachelor of Science in Physics (Honours) with a Minor in Mathematics, University of New Brunswick

Publications:

Amy-Rae Gauthier, Benedict Newling, *Magnetic Resonance Imaging of Fast Turbulent Gas Flow*, Physics in Canada 74 (2018) 119-122.

Amy-Rae Gauthier, Benedict Newling, *Gas flow mapping in a recorder: an application of SPRITE MRI*, Applied Magnetic Resonance 49 (2018), no. 10.

Presentations:

A. Gauthier, N. Stocek, B. Newling, “Method improvements for Diffusion Tensor Imaging of turbulent fluids", Poster at the International Conference on Magnetic Resonance Microscopy (2019) - Winner of the Poster Competition

A. Gauthier, “Developing a diffusion tensor imaging technique for turbulent flow", UNB Physics department seminar (2018)

A. Gauthier, B. Newling, “Magnetic resonance imaging of fast turbulent gas flow", Oral presentation at CAP Congress (2018) - Winner of the DPE-DAPI Divisional best student oral presentation award and the CAP Congress First prize best student oral presentation award

A. Gauthier, “Applying diffusion tensor imaging to a turbulent gas flow system", UNB Physics department seminar (2017) - Winner of the Don Hornibrook Graduate Student Prize

A. Gauthier, B. Newling, “The application of diffusion tensor imaging to a turbulent gas flow system", Oral presentation at the International Conference on Magnetic Resonance Microscopy (2017)

A. Gauthier, “Time-averaged velocity field (and diffusivity!) measurement using motion-encoded SPRITE", UNB Physics department seminar (2017)

A. Gauthier, B. Newling, “Recorder velocimetry using MRI", Oral presentation at MOOT29 (2016) - Winner of the Best Student Presentation award

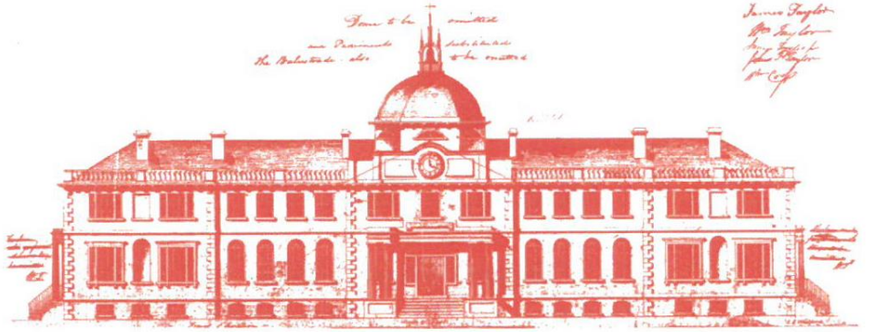
A. Gauthier, B. Newling, “Magnetic resonance imaging of gas velocity in a recorder", Oral presentation at the UNB Graduate Research Conference (2016)

Characterizing and Quantifying Turbulent Flow using Magnetic Resonance

Abstract

"I am an old man now, and when I die and go to heaven there are two matters on which I hope for enlightenment. One is quantum electrodynamics, and the other is the turbulent motion of fluids. And about the former I am rather optimistic."
-Sir Horace Lamb, in a 1932 address to the British Association for the Advancement of Science

Fluid turbulence is found everywhere in nature and in many engineering applica-tions. Although the equations governing turbulent flow have not yet been solved analytically, advances have been made in the measurement of this phenomenon. The aim of this work is to contribute Magnetic Resonance (MR) methodologies to the arsenal of measurement methods that can help unravel the mystery of fluid tur-bulence. Magnetic Resonance is well-suited to the measurement of turbulent flow because it is non-invasive. Three turbulent systems are studied in this thesis: a pipe, a pipe with a constriction, and a baroque recorder. In the recorder, velocity is mea-sured using motion-sensitized Single Point Ramped Imaging with T1 Enhancement (SPRITE) and preliminary estimates of the degree of turbulence are extracted from this data. In a pipe with a constriction, motion-sensitized SPRITE is once again employed, but this time with motion sensitization applied along two Cartesian axes simultaneously to build up a full picture of anisotropic turbulence. The technique is akin to Diffusion Tensor Imaging which is used in clinical applications to measure fibrous tissues like the brain and muscles. In both a straight pipe and a pipe with a constriction, a new technique called Rapid Acceleration and Velocity Encoding (RAVE) is used to measure velocity and acceleration distributions. Together, these MR-based methodologies can be used to explore turbulence and hopefully shed some light on this chaotic and complicated phenomenon.



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

Amy-Rae Gauthier

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY