



**University  
of Victoria**

Graduate Studies

Notice of the Final Oral Examination  
for the Degree of Master of Science

of

**JUAN PABLO HERNANDEZ**

BSc (McGill University, 2015)

**“Exploring the Fluid Landscape: Three New Regimes of Relativistic  
Hydrodynamics”**

Department of Physics and Astronomy

August 18, 2017

10:00 A.M.

David Turpin Building

Room A144

Supervisory Committee:

Dr. Pavlo Kovtun, Department of Physics and Astronomy, University of Victoria (Supervisor)  
Dr. Adam Ritz, Department of Physics and Astronomy, UVic (Member)

External Examiner:

Prof. Alex Buchel, Department of Physics and Astronomy, University of Western Ontario

Chair of Oral Examination:

Dr. Annalee Lepp, Department of Gender Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

## **Abstract**

In this work, we use the recently developed equilibrium generating functional and systematic derivative expansion approach to hydrodynamics to explore three new regimes of relativistic hydrodynamics. First, we derive the equations of motion and write the constitutive relations to first order in derivatives for relativistic fluids coupled to an external vector field. Next, for relativistic fluids in strong magnetic fields  $B_\mu \sim O(1)$ , we derive the equations of motion and present the constitutive relations to first order in derivatives. From the resulting system of equations, we find the hydrodynamic modes for these systems. We also find the constraints on the transport coefficients due to the entropy production argument and derive the corresponding Kubo formulas. Finally, we repeat the same analysis for relativistic fluids coupled to dynamical electromagnetic fields with  $(B_\mu) \sim O(1)$ .