



Mathematics

UNIVERSITY OF TORONTO

## Departmental PhD Thesis Exam

Monday, June 10, 2024 at 2:00 p.m. (sharp)  
Via Zoom

**PhD Candidate:** Saeyon Mylvaganam

**Supervisor:** Stefanos Aretakis

**Thesis title:** The Null Gluing Problem and Conservation Laws for Maxwell's Equations

We study the null gluing problem for Maxwell's equations along null hypersurfaces. By studying a weaker formulation of the gluing problem, which we call the  $k$ th-order gluing problem, we classify all possible conservation laws by proving that they are the only obstructions to gluing. We derive sets of conserved charges for the zeroth-order gluing problem along general null hypersurfaces and the first-order gluing problem along extremal horizons. We derive an elliptic structure related to a foliation with 2-spheres of a null hypersurface, using a similar method introduced in [9] by Aretakis. We also show the non-existence of zeroth-order conservation laws along extremal horizons and the non-existence of  $k$ th-order conservation laws for spherically symmetric extremal horizons by using a hierarchy of  $v$ -weighted integrals of the Maxwell equations. Finally, we determine how the space of these conserved charges changes under a change of foliation by understanding the gauge covariance of the elliptic structure.