

# Thesis Proposal: Quantum ‘Particles’ In a Classically Defined Spacetime

Lara D. Mercurio  
Advisor: Thomas Helliwell

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## **Project Description:**

Historically, a physical singularity is defined in terms of classical mechanics. A classical particle in free-fall will travel along a geodesic; if a geodesic ends at a point such that the particle cannot move from that position, that point is called a singularity. One example of this is a particle moving toward a black hole. Because the particle can take no path to leave the center of the black hole, that point is called a singularity. Similarly, the point of an infinitely sharp cone would also be considered a singularity.

The advent of quantum mechanics, however, has replaced classical particles with wavefunctions. The question for study now is how these quantum wavefunctions, rather than classical particles, interact with classical singularities. In particular, at a singularity, do wavefunctions behave similarly to classical particles? This question is fundamental to Professor Helliwell’s research, and I will be joining him in this research in the fall.

This work applies the coupled, hyperbolic-elliptic non-linear PDEs of Einstein’s field equations and tensor mechanics to physical situations. Before working with Professor Helliwell, I will study the mathematics involved in relativistic theory. In addition, I plan to take Topics in Quantum Theory to further study the quantum mechanics involved.

Once I am more familiar with general relativity, it is possible that I will discover a different project to work on that is unrelated to Professor Helliwell’s research, such as Jimmy Corno’s work involving frame dragging around black holes. Such a project would involve the same degree of mathematical complexity as the one proposed, as the mathematics is specific to the field of general relativity, not the problem itself.