Ph.D. Candidate

Robert Santacruz

Graduate Academic Unit

Mathematics & Statistics

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February 13, 2023

9:00 a.m. (Atlantic)

Virtual Defence

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Examining Board:
Dr. Viqar Husain (Mathematics & Statistics)
Dr. Sanjeev Seahra (Mathematics & Statistics)
Dr. Ben Newling (Physics)
Dr. Edward Wilson-Ewing Mathematics & Statistics) Supervisor

External Examiner: Dr. Francesca Vidotto
          Department of Physics and Astronomy
          Western University

The Oral Examination will be chaired by:
Dr. Erin Morton, Acting Associate Dean of Graduate Studies

BIOGRAPHY

<u>**Universities attended**</u> **(with dates & degrees obtained):**
2018 – present   Ph.D. candidate, University of New Brunswick
2017   M.Sc. in Theoretical Physics, Universitat de València
2016   B.Sc. in Physics, Universitat of València

<u>**Publications:**</u>

Husain, V., Kelly, J., **Santacruz, R** & Wilson-Ewing, E. Fate of quantum black
      holes. Phys. Rev. D. **106**, 024014 (2022).

Husain, V., Kelly, J., **Santacruz, R**. & Wilson-Ewing, E. Quantum Gravity of
      Dust Collapse: Shock Waves from Black Holes. Phys. Rev. Lett.. **128**, 121301
      (2022)

Kelly, J., **Santacruz, R**. & Wilson-Ewing, E. Black hole collapse and bounce in
      effective loop quantum gravity. Class. Quant. Grav.. **38**, 04LT01 (2021).

Kelly, J., **Santacruz, R**. & Wilson-Ewing, E. Effective loop quantum gravity
      frame-work for vacuum spherically symmetric spacetimes. Phys. Rev. D. **102**,
      106024(2020)

<u>**Conference Presentations:**</u>

Quantizing gravity is easy Talk at Atlantic GR, Online, 2020

Another one bites the dust Talk at 4th València Winter Workshop, València (Online)
2020

Collapse and bounce in effective loop quantum gravity Talk at Canadian Association of
      Physicists online conference, Online, 2021.

LTB in canonical formalism Talk at 16th Marcel Grossman Meeting, Online, 2021.

Shockwaves from black holes

Abstract

Black holes are among the most interesting objects in the universe. While in the classical description of gravity (general relativity) these objects contain singular points in which the theory breaks down, it is expected that these problematic points are avoided in a quantum theory of gravity. In this thesis, I present two different models based on an effective description of loop quantum gravity: a vacuum description of black holes and an extension for matter collapse. The study of the vacuum model is presented in Chapter 2 and the matter collapse is described in Chapters 3, as a first point of contact, and 4, which contains a more detailed analysis in both analytic and numerical calculations. The features and predictions that these models offer are several: i) provide a comprehensive evolution of dust matter collapse; ii) present a bounce after the contracting phase of matter; iii) the black hole disappears, emitting a shock wave; iv) the lifetime of the black hole is predicted to be proportional to its mass squared.
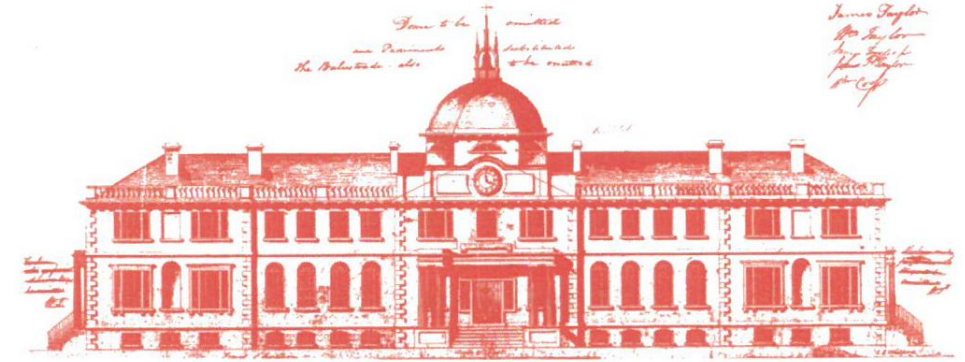
Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

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

Robert Santacruz

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY