UNIVERSITY OF MIAMI
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University of Miami, Physics Department Colloquium

Date: Wednesday, February 26th, 2025
Time: 4:00 pm – 5:00 pm
Location: Wilder Auditorium – Room 112, Knight Physics Building

Using Mathematical Models and AI to Unravel the Biological Effects of Radiation from Single-Cell Data to Patient Outcomes

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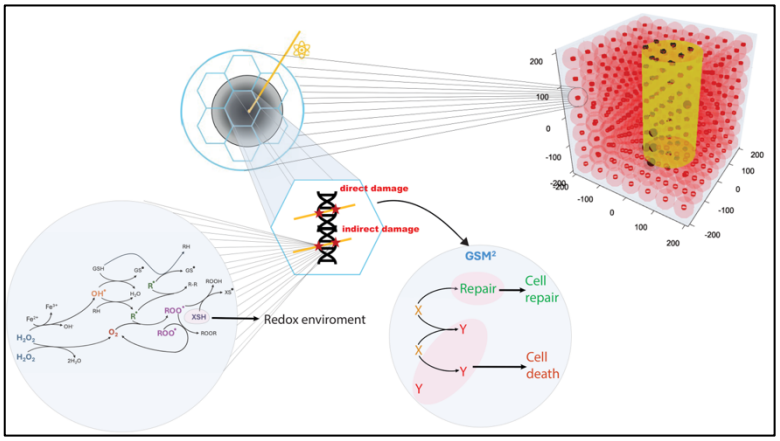
Abstract

In this talk, I will explore two approaches to understanding the biological effects of radiation in particle therapy: mathematical modeling and advancements in Artificial Intelligence (AI). I will present the development of the Generalized Stochastic Microdosimetric Model (GSM^2), from its foundational principles and initial in vitro validation to recent advancements. These include a multiscale extension incorporating fast chemical networks to elucidate a novel, yet unexplained, mechanism in radiobiology critical to FLASH radiotherapy and a new agent-based model for predicting patient outcomes in radiotherapy.



Additionally, I will introduce ANAKIN, a data-driven AI model designed to predict both in vitro and clinical outcomes while offering valuable insights into underlying biological mechanisms. By leveraging AI, I will demonstrate how integrating multiple spatial scales and diverse descriptions of radiation interactions with biological tissue enhances our ability to predict and understand the biological effects of radiation. Finally, I will discuss the synergy between mathematical and AI-driven models, illustrating how their integration can refine predictions, deepen our understanding of radiation response, and ultimately optimize therapeutic strategies in particle therapy.

Biography: Dr. Francesco G. Cordoni is a mathematician specializing in mathematical modeling for physical and biological systems. He earned his Ph.D. in Mathematics from the University of Trento and was appointed tenure-track Assistant Professor in Probability and Statistics at the same institution in 2021. Since 2024, he has been an Associate Professor at the University of Trento. His research focuses on understanding the biological effects of radiation, particularly in hadron therapy. He is developing advanced models integrating AI with traditional mathematical frameworks to enhance predictive accuracy and deepen biological insights.