UNIVERSITÀ DEGLI STUDI DI TRIESTE

Dynamical Friction and the Evolution of Massive Black Holes in Cosmological Simulations

PhD Candidate Alice Damiano

Supervisors: Stefano Borgani (UNITS), Milena Valentini (UNITS)

Alice Damiano presented her work in a 40 minute seminar. She first introduced the topic by talking about the physics behind the treatment of black holes in N-body hydrodynamical simulations, then presented the methodology used in her work, that is based on the OpenGadget code developed between Trieste and Munich. She focused on dynamical friction, responsible for dragging black holes at the center of their host halo, and highlighted the challenges of modeling this effect in cosmological simulations that have finite resolution. She then discussed three projects that focus on various aspects of the problem outlined above: the sub-resolution modeling of dynamical friction, the results on a set of idealized simulations, and the modeling of BH accretion and feedback in the same simulations. The talk was excellent in terms of presentation and content, she demonstrated a high degree of awareness of the topic discussed and highlighted her contribution to the work. She also replied very competently to the questions raised by the audience. The panel is very positive on her performance, and has no doubt that the final PhD exam will be successful.

Committee
Stefano Borgani
Gabriella De Lucia
Marisa Girardi
Pierluigi Monaco

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Advancing Cosmological Simulations with GPU-Enabled PINOCCHIO: From Dark Matter Halos to Cosmic Voids

PhD Candidate Marius Lepinzan

Supervisors: Pierluigi Monaco (UNITS), Luca Tornatore (INAF), Tiago Castro (INAF)

Marius Lepinzan presented his work in a 40 minutes seminar. He first introduced the topic of his project, which focussed on the development and use of Pinocchio, a code to carry out cosmological simulations based on Lagrangian Perturbation Theory. In the first part of his presentation he showed the results on the development activity for the GPU offloading of parts of the Pinocchio code, highlighting the improved performances in terms of both computational efficiency and energy saving. In the second part he focused on a project of application of Pinocchio simulations to accurately predict statistical properties of cosmic voids. Switching to the different framework of data analysis, Marius presented an algorithm that he developed to carry out deblending of images of galaxies in crowded fields, discussing the potential applications for the analysis of imaging and photometric data from the survey from the Euclid satellite. The talk was excellent in terms of organization, clarity of exposition and content. Marius demonstrated a high degree of awareness of the topic discussed, and highlighted his original contribution to the work. He also replied very competently and professionally to the questions raised by the audience. The panel is very positive on his performance, and has no doubt that the final PhD exam will be successful.

Committee
Stefano Borgani
Gabriella De Lucia
Marisa Girardi
Pierluigi Monaco

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Quantum Algorithms for Cosmological Simulations

PhD Candidate Luca Cappelli

Supervisors: Giuseppe Murante (INAF), Stefano Borgani (UNITS)

Luca Cappelli presented his work in a 40 minutes seminar. He first presented an outline of the results, highlighting the points where the project was successful and those where a solution was not found (a failure in such a pioneering project is not considered as a problem). In particular, the idea of mapping the Vlasov-Poisson equation of cosmology, that regulates the evolution of dark matter perturbations, to a Schroedinger-Poisson problem had good potentiality but the results were not convincing enough to foresee a real application to quantum computers. Conversely the problem in neighbour search, that is important in Smoothed Particle Hydrodynamics and in many other codes, was found to have more convincing potentiality. The content of the talk was excellent, the exposition well organized and very honest on the results. Luca demonstrated a high degree of awareness of the topic discussed, and replied very competently and professionally to the questions raised by the audience. The panel noticed that clarity of the presentation was possibly not at its best, however we are very positive on the quality of his work, and have no doubt that the final PhD exam will be successful, once some more effort is devoted to improve the presentation.

Committee
Stefano Borgani
Gabriella De Lucia
Marisa Girardi
Pierluigi Monaco

UNIVERSITÀ DEGLI STUDI DI TRIESTE

From Fuzzy Spacetime to Classical Reality

PhD Candidate Laria Figurato

Supervisors: Angelo Bassi. Co-supervisors: Matteo Carlesso and Sandro Donadi

In her talk, Laria Figurato presented the main results of her PhD thesis “From Fuzzy Spacetime to Classical Reality”, focused on the role of gravity in the quantum-to-classical transition. The work is framed within open quantum systems and collapse models, and investigates two gravitational mechanisms: decoherence induced by a “fuzzy” spacetime (the Károlyházy model) and gravity-driven wave-function collapse (the Diósi–Penrose model). In the first part, she revisits and generalizes Károlyházy’s proposal by allowing more general spacetime fluctuations, identifying which versions remain theoretically consistent and experimentally viable. In the second part, she presents the Diósi–Penrose model to locate the boundary between microscopic and macroscopic behaviour and to estimate collapse times for visible objects, including the impact of memory (non-Markovian) effects. The presentation was very clear and engaging. It demonstrated a great amount of work performed during the PhD, which is difficult to contain in the limited time given for the presentation. The committee recommends to admit her to the final presentation.

Committee
Angelo Bassi
Matteo Carlesso
Ugo Marzolino

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Geophysical Applications of Quantum Gravimiters

PhD Candidate Ivaldevingles Rodrigues

Supervisors: Andrea Trombettoni and Carla Braitenberg.

The presentation focused on quantum gravimeters as a new generation of instruments for measuring the local gravitational acceleration with high precision and long-term stability. After a brief introduction on quantum gravimetry and their description by the Schroedinger equation, the PhD candidate introduced the material from geophysics needed to consider applications to fluid substitution for realistic applications. The Kimberlina and MRST synthetic models were finally discussed comparing the performance of ultracold quantum gravimeters with other types of gravimeters. The candidate expertise at the beginning of the PhD was on geophysics and the quantum mechanics competences were acquired during the PhD. The talk bridged the two fields in a clear way. However, the commission recommends a clearer focus on the physical motivations of the work done with less emphasis on the more technical details. He also replied very competently to the questions raised by the audience. The panel is positive on his performance, and about his admittance to the final PhD exam.

Committee
Carla Braitenberg
Luis Peña Ardila
Andrea Trombettoni

UNIVERSITÀ DEGLI STUDI DI TRIESTE

On the Classical and Quantum Aspects of Information Flows in non-Markovian Open Systems

PhD Candidate Giovanni Nichele

Supervisors: Fabio Benatti. Co-supervisor: Angelo Bassi

In his talk, Giovanni Nichele presented the main results of his PhD thesis entitled “On the Classical and Quantum Aspects of Information Flows in non-Markovian Open Systems” which focussed on the role of non-Markovianity in the phenomenon known as Back-Flow of Information (BFI), both in classical and quantum open systems. In his work the candidate used the algebraic approach to quantum dynamical systems to investigate the entropy production in collisional models where quantum open systems interact at discrete times with an environment represented by an infinite spin chain. In particular, in the case of a classical Markov chain as environment, the BFI and its peculiar quantum properties, like being super-activated by statistically coupling two dynamically independent quantum systems, could be clearly related to the strength of the chain correlations. The candidate also showed how non-Markovian memory effects can be assessed by studying multi-time correlation functions and the associated quantum dynamical entropy introduced by Alicki and Fannes. The presentation was excellent as well as the reply to the questions raised by the audience. The candidate showed a full mastering of all the issues he addressed during his PhD studies. The committee warmly recommends his admission to the final exam.

Committee:
Fabio Benatti
Matteo Carlesso
Ugo Marzolino

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Simulations of two-dimensional crystalline and amorphous oxides

PhD Candidate Marco Dirindin

Supervisors: Daniele Coslovich (UniTs), Maria Peressi (UniTs)

Marco Dirindin presented the results of his PhD project on the simulation of two-dimensional oxides. In the first part of the presentation, he described an optimized interaction model for the amorphous silica bilayer, which he simulated using molecular dynamics techniques. In the second part, he focused on the results of ab-initio simulations for the crystalline boron oxide monolayer. His results were essential for understanding the physical properties of the boron oxide monolayers recently synthesized at the CNR-IOM lab in Basovizza. He also described his original contribution to the analysis of the experimental STM images obtained at the CNR-IOM lab. Throughout the presentation, the candidate carefully compared his results to experimental data and interpreted them in the framework of the existing theories of two-dimensional materials. The presentation was clear and very well organized. The candidate replied competently to all the questions raised by the audience after his presentation. The committee supports the submission of the thesis for the final PhD exam.

Committee
Daniele Coslovich
Maria Peressi
Francesco Scazza
Erik Vesselli

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Structure and reactivity of biomimetic iron-centered 2D materials from ultra-high vacuum to near-ambient pressure

PhD Candidate Alessandro Namar

Supervisors: Erik Vesselli (UniTs), Mattia Scardamaglia (MAX IV – Lund University)

Alessandro Namar presented his work in a 35-minute seminar, followed by a discussion with the Committee. The aim of his work was to investigate novel 2D materials based on metalorganic architectures, inspired by strategies already adopted by nature for processes such as light harvesting, chemical conversion and synthesis. He focused on iron-centered 2D materials, namely FeTPyP and hemin self-assemblies. The experimental characterization exploited state-of-the-art methods and novel approaches to determine geometric and electronic structures, as well as the reactivity properties beyond standard UHV conditions. The presentation was very good in terms of slideshow and content, demonstrating a thorough personal contribution within an international collaboration framework. He demonstrated sufficient degree of awareness of the topic and replied accordingly to the questions raised by the audience. The panel supports submission of the thesis for the final PhD exam.

Committee
Daniele Coslovich
Maria Peressi
Francesco Scazza
Erik Vesselli