BRIT24

Brazilian-Italian Students Network

BRIT24, the Brazilian-Italian Students Network, is a collaborative initiative connecting high school and university students from Brazil and Italy. The project promotes international cooperation by involving students in solving quantum mechanics and optics problems through theoretical analysis, programming, graphical visualization, and practical applications. It also emphasizes cultural exchange, preparing students for future scientific and technological challenges on a global scale.

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Coordinator and Project Manager: Prof. Stefano De Leo

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Theoretical Aspects

A detailed exploration of the fundamental differential equations that govern both quantum mechanics and optics, such as the Schrödinger equation and the Maxwell's equations. The focus is on phenomena like tunnelling, interference, and diffraction, with a strong emphasis on the mathematical models used to describe quantum states, probability amplitudes, and wave propagation.

Software Development

Design and implementation of algorithms and computational tools for simulating quantum mechanical behaviour and light propagation in nanostructures. This involves numerical methods such as finite difference and time-dependent simulations, enabling analysis of dynamic quantum phenomena and photonic effects at the nanoscale.

Graphical Visualization

Creation of high-resolution graphical models and interactive visualizations to represent quantum phenomena like tunneling, resonance, and wave packet dynamics. These visualizations facilitate a deeper understanding of abstract quantum behaviors, offering clear insights into concepts such as quantum superposition, interference patterns, and localized states in nanostructures.

Quantum Mechanics vs. Optics

In-depth study of the analogies between quantum mechanical processes and optical phenomena, including comparisons of quantum delay times, lateral beam shifts (Goos-Hänchen effect), and angular deviations. By analyzing wave functions in quantum mechanics alongside electromagnetic waves in optics, the project aims to reveal new insights into energy transfer, coherence, and phase shifts.

Energy Optimization

Investigation into energy efficiency improvements through quantum mechanical and optical phenomena. The focus is on exploiting quantum tunneling, resonance effects, and photonic bandgap engineering to develop materials and technologies aimed at optimizing energy use, with applications in photovoltaic systems, thermoelectric devices, and quantum dot technologies for energy harvesting.

International Collaboration

The project is structured in phases to promote international collaboration. In the first phase, mixed teams of Brazilian and Italian students, both from high schools and universities, work together under the guidance of experienced professors. In the second phase, remote collaboration tools are used to continue joint efforts, fostering cross-border communication. The final phase involves student exchanges, where selected Brazilian students will visit the University of Salento, and Italian students will participate in research at the University of Campinas, encouraging both academic and cultural immersion.

Main Objectives

- Conduct a comprehensive theoretical and practical analysis of key problems in quantum mechanics and optics, with a particular focus on nanoscale applications.
- Develop advanced software and simulation models to investigate quantum phenomena and light-matter interactions in nanostructured materials.
- Utilize graphical tools and interactive simulations to visualize, understand, and communicate complex results effectively.
- Implement cutting-edge solutions in nanotechnology with direct applications in energy efficiency and material science.

Expected Impact

The BRIT24 project aims to:

- Foster international collaboration, innovation, and knowledge transfer between Brazilian and Italian institutions, inspiring future partnerships and research networks.

- Deepen the understanding of critical quantum mechanical phenomena, particularly related to energy transfer, resonance, and tunneling effects.
- Contribute to the development of novel materials and nanotechnologies aimed at optimizing energy use and enabling breakthrough applications in energy, communication, and information technologies.

Contact Information

Professors *Stefano De Leo* and *Marco Mazzeo* will be available in person **from 19:15 to 20:15** to provide additional clarifications and information regarding the BRIT24 project. This is an excellent opportunity to ask questions and gain a deeper understanding of the project.

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