UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

PhD Course in Physics and Astronomy
XXXVI cycle, a.y. 2020/2021

n.3 scholarships funded by Department, linked to the research project: " *Integrated circuits design for industrial applications".*

Abstract

The activity covered by the doctoral scholarships concerns the development of the circuits and architectures of microelectronic devices to be realized in the form of an integrated circuit. These devices will be designed to be used in industrial applications of different nature, both for signal processing and for power management. For this purpose, the activity, considering the use of CMOS and BCD technologies, will require the development and acquisition of knowledge related to the physical behavior of such semiconductor devices.

n.1 scholarship funded by Department, linked to the research project: " *Improving Monte Carlo event generators for the LHC and future colliders".*

Abstract

The goal of this project is to push forward the frontier of precision QCD for event simulations by combining the threepossible theoretical description (fixed-order perturbative expansion, resummed calculations and parton showers) into the same theoretical framework, in order to benefit from the advantages of each. Of particular importance is the inclusion of higher-logarithmic resummation, which bridges the gap between the perturbative description of hard radiation and the shower domain. This project will focus on the study and implementation of novel techniques for the production of color singlets at the LHC and future colliders.

n.1 scholarship funded by Department, linked to the research project: "*Morphology and Kinematics of Cosmic Web filaments"*

Abstract

Our current cosmological models suggest that the matter in the universe is distributed in a "Cosmic Web" of filaments in which galaxies form and evolve. Most of the matter in the "Cosmic Web" is thought to be too diffuse to form stars, making its direct imaging difficult. As a result, several fundamental questions about the large and small-scale structure of our universe and how galaxies acquire their gas from the Cosmic Web are still mostly unaddressed. The PhD candidate for this position will investigate these questions using innovative methods that combine numerical models

with deep observations around bright quasars that "illuminate" the surrounding Cosmic Web in fluorescent Ly-alpha emission. Preference will be given to candidates with previous experience with cosmological simulations that could be used to better understand the main physical properties of cosmic structures observable in fluorescent Ly-alpha emission.

n.1 scholarship funded by Department, linked to the research project: "*Muonic Atom X-ray Spectroscopy: implementation and benchmark of Monte Carlo simulation codes for non-destructive measurements*".

Abstract

The focus of this project is to continue the development of the unique capabilities offered by the RIKEN-RAL muon facility in non-destructive elemental analysis of advanced materials, including cultural artefacts dating from 2000 BCE to 2000 CE. Detecting the high-energy X-rays emissions that follow from negative muons implanted in the matter, it is possible to probe beneath the surface, making this technique a novel and potentially powerful non-destructive probe. In order to achieve reliability, accuracy and precision in determining the elemental content and isotopic ratios in a sample of any shape and material, it is critical to have software that precisely implements in an optimal way the whole experimental set-up (muon beam-sample-detection system). For this purpose, the main scope of the project is to develop the data analysis for negative muon experiments including GEANT4, PHITS, FLUKA and MCNPX simulations of muonic X-ray emission, testing Monte-Carlo simulations of different configurations of HPGe's detector array to choose the appropriate HPGe detectors in terms of resolution and efficiency, maximizing the solid angle coverage.

n. 1 scholarship funded by Eni S.p.A. linked to the research project: *"Development of radiation detectors based on SiC for neutron measurements on a fusion reactor"*.

Abstract

Nuclear measurements on future DT fusion reactors such as ITER and DEMO will play a key role. Absolute flux measurements of 14 MeV neutrons emitted by T+D->⍰ + n reaction provide a direct method to measure the fusion power, while the plasma ion temperature and quality of the thermonuclear fusion gain Q (so called Q thermal/non-thermal) can be determined by a high resolution measurements of the 14 MeV neutron spectrum.
New neutron detectors must be developed which features compact size, insensitive to magnetic field and are resistance to neutron damage. Solid state detectors such as SiC and artificial diamonds features these characteristics. The Ph.D work will focus on SiC and diamonds neutron detectors for fusion reactors. It will employ development of Monte Carlo simulations to study the neutron field and detector response in the fusion environment. When neutron detectors are used closed to the tokamak the fraction of direct/scattered neutrons has to be known for a correct interpretation of the measured data. Part of the work will be dedicated to the optimization of a dedicated SiC electronic chain in order to match the high count rate capability (>MHz), required for high time-resolution measurement of the fusion power, and good energy resolution (<5%) required for ion temperature measurement. The developed detectors will be characterized in laboratory with radioactive sources

and at mono-energetic neutron sources for detector response studies, before the installation and exploitation on a fusion experiment.