Dottorato di Ricerca in Fisica

Matti e disperatissimi

Seminari dei futuri Dottori di Ricerca

7 febbraio 2014

Aula A, Via Irnerio 46

Orario	Dottorando	Relatore
10.00	Andrea Agostinelli	Prof. Cifarelli
	Vector Meson Photoproduction in ultra-peripheral heavy ion collisions with ALICE at the LHC	
10.30	Matteo Franchini	Prof. Zoccoli
	Measurements of $t\bar{t}$ differential cross section at the ATLAS experiment in pp collisions at $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV	
11.00	Federica Primavera	Prof. Navarria
	Search for the Neutral MSSM Higgs Boson in the $\mu^+\mu^-$ final state with the CMS experiment at LHC	
11.30	Stefano Sinigardi	Prof. Turchetti
	Laser driven proton acceleration and beam shaping	
12.00	Stefania Carapezzi	Prof. Cavallini
	Scaled down physical properties of semiconductor nanowires for nanoelectronics scaling up	
14.30	Alessandro Fabbri	Prof. Ravanini
	Quantum Integrability in Non-Linear Sigma Models related to Gauge/String correspondences	
15.00	Simone Piscaglia	Prof. Ravanini
	On the GKP Vacuum in Gauge/Gravity Correspondences	
15.30	Lucia Andreani	Prof. Baldazzi
	Development of an X-ray spectrometric system and feasibility tests of Silicon Drift Detector for medical and space applications	
16.00	Massimo Brighi	Prof. Soldati
	Implicazioni teoriche e sperimentali della sincronizzazione assoluta nella teoria della relatività speciale	

Vector Meson Photoproduction in ultra-peripheral heavy ion collisions with ALICE at the LHC

Andrea Agostinelli

Ultra-relativistic heavy ions generate strong electromagnetic fields which offer the possibility to study $\gamma - \gamma$ and $\gamma-$nucleus processes at the LHC in the so called ultra-peripheral collisions (UPC). The photoproduction of J/Ψ vector mesons in UPC is sensitive to the gluon distribution of the interacting nuclei. In this thesis the study of coherent and incoherent J/Ψ production in Pb-Pb collisions at $\sqrt{s}$NN = 2.76 TeV is described. The J/Ψ has been measured via its leptonic decay in the rapidity range $-0.9 < y < 0.9$. The cross section for coherent and incoherent J/Ψ are given. The results are compared to theoretical models for J/Ψ production and the coherent cross section is found to be in good agreement with those models which include nuclear gluon shadowing consistent with EPS09 parametrization. In addition the cross section for the process $\gamma - \gamma \rightarrow e^+ e^-$ has been measured and found to be in agreement with the STARLIGHT Monte Carlo predictions. The analysis has been published by the ALICE Collaboration in the European Physical Journal C, with one of its main plot depicted on the cover-front of the November 2013 issue.

Measurements of $t\bar{t}$ differential cross section at the ATLAS experiment in pp collisions at $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV

Matteo Franchini

This PhD thesis presents two measurements of differential production cross section of top and anti-top pairs $t\bar{t}$ decaying in a lepton+jets final state. The normalize cross section is measured as a function of the top transverse momentum and the $t\bar{t}$ mass, transverse momentum and rapidity using the full 2011 proton-proton (pp) ATLAS data taking at a center of mass energy of $\sqrt{s} = 7$ TeV and corresponding to an integrated luminosity of $\mathcal{L} = 4.6$ fb^{-1}. The cross section is also measured at the particle level as a function of the hadronic top transverse momentum for highly energetic events using the full 2012 data taking at $\sqrt{s} = 8$ TeV and with $\mathcal{L} = 20$ fb^{-1}. The measured spectra are fully corrected for detector efficiency and resolution effects and are compared to several theoretical predictions showing a quite good agreement, depending on different spectra.

Search for the Neutral MSSM Higgs Boson in the $\mu^+\mu^-$ final state with the CMS experiment at LHC

Federica Primavera

In this thesis, my work in the Compact Muon Solenoid (CMS) experiment on the search for the neutral Minimal Supersymmetric Standard Model (MSSM) Higgs decaying into two muons is presented. The search is performed on the full data collected during the years 2011 and 2012 by CMS in proton-proton collisions at CERN Large Hadron Collider (LHC).

The MSSM is explored within the most conservative benchmark scenario, m_h^{max}, and within its modified versions, m_h^{mod+} and m_h^{mod-}. The search is sensitive to MSSM Higgs boson production in association with a $b\bar{b}$ quark pair and to the gluon-gluon fusion process.

In the m_h^{max} scenario, the results exclude values of $\tan\beta$ larger than 15 in the m_A range 115-200 GeV, and values of $\tan\beta$ greater than 30 in the m_A range up to 300 GeV. There are no significant differences in the results obtained within the three different scenarios considered. Comparisons with other neutral MSSM Higgs searches are shown.

Laser driven proton acceleration and beam shaping

Stefano Sinigardi

In the race to obtain protons with higher energies, using more compact systems at the same time, laser-driven plasma accelerators are becoming an interesting possibility. But for now, only beams with extremely broad energy spectra and high divergence have been produced.

The driving line of this PhD thesis was the study and design of a compact system to extract a high quality beam out of the initial bunch of protons produced by the interaction of a laser pulse with a thin solid target, using experimentally reliable technologies in order to be able to test such a system as soon as possible.

In this thesis, different transport lines are analyzed. The first is based on a high field pulsed solenoid, some collimators and, for perfect filtering and post-acceleration, a high field high frequency compact linear accelerator, originally designed to accelerate a 30 MeV beam extracted from a cyclotron.

The second one is based on a quadruplet of permanent magnetic quadrupoles: thanks to its greater simplicity and reliability, it has great interest for experiments, but the effectiveness is lower than the one based on the solenoid; in fact, the final beam intensity drops by an order of magnitude.

An additional sensible decrease in intensity is verified in the third case, where the energy selection is achieved using a chicane, because of its very low efficiency for off-axis protons.

The proposed schemes have all been analyzed with 3D simulations and all the significant results are presented. Future experimental work based on the outcome of this thesis can be planned and is being discussed now.

Scaled down physical properties of semiconductor nanowires for nanoelectronics scaling up

Stefania Carapezzi

Semiconductor nanowires (NWs) are one- or quasi one-dimensional systems whose physical properties are unique as compared to bulk materials because of their nanoscaled sizes. NWs-based technologies may achieve an impact comparable to that of current microelectronic devices if new challenges will be faced. One of these is to understand how NWs synthesis conditions induce the formation of electrical levels in their bandgap. The study of defects in NWs is a field that is presently at its earliest stage, and many difficulties both technological and theoretical have to be overcome in order to adapt the traditional characterization techniques to the detection of defects in these new structures. The thesis research has been mainly focused on the setting-up of a general procedure for probing electrically active defects in semiconductor NWs by means of Deep Level Transient Technique (DLTS). DLTS is a well established method in the field of defect characterization as regards bulk semiconductors. However, technical limitations inherent to it together with intrinsic electrical properties of semiconductor NWs have prevented up to now its application to single semiconductor NWs. The devised experimental procedure has been applied to characterize Reactive Ion Etched (RIE) silicon NW arrays. A pivotal step has been the fabrication of RIE Si array-based Schottky barrier diodes (SBDs). Devices based on unprocessed and RIE etched Si substrates have also been characterized, to identify the deep levels associated to the RIE processing of bulk samples. While the unprocessed Si substrate has showed to possess no defect-related peak in its DLTS spectra, those of the RIE processed substrate have demonstrated that the RIE etching has introduced defects into the bulk Si. Interestingly, the defects in the RIE etched Si substrate and in the Si Grass appear to be different. This has been put into relation with differences in damage mechanisms between horizontal surface and sidewalls inherent to the RIE etching process.

Quantum Integrability in Non-Linear Sigma Models related to Gauge/String correspondences

Alessandro Fabbri

The Thermodynamic Bethe Ansatz analysis is carried out for the *extended*-$\mathbb{CP}^{N-1}$ class of integrable 2-dimensional Non-Linear Sigma Models. The principal aim of this program is to find non-perturbative consistency check for the S-matrix proposed to describe the scattering processes between the fundamental excitations of the theory, by analyzing the structure of the Renormalization Group fl ow. As a noteworthy byproduct we eventually obtain a novel class of TBA models, the $(\mathbb{CP}^{N-1})_p \times U(1)$ models, which fi ts in the known classi cation but with several important di fferences. The TBA framework allows the evaluation of some exact quantities related to the conformal UV limit of the model: eff ective central charge, conformal dimension of the perturbing operator and field content of the underlying CFT. The knowledge of this physical quantities has led to the possibility of conjecturing a perturbed CFT realization of the integrable models in terms of coset Kac-Moody CFT.

On the GKP Vacuum in Gauge/Gravity Correspondences

Simone Piscaglia

Within the framework of the AdS_5/CFT_4 correspondence, the GKP string living on a $AdS_5 \times S_5$ background finds a counterpart in the antiferromagnetic vacuum state for the spin chain, fruitfully employed to investigate the dual N=4 SYM superconformal gauge theory. Integrability in such a model allows to analyse the excitations over the vacuum considered, by computing their scattering matrices and dispersion relations. Furthermore, the survey of the GKP vacuum within the AdS_4/CFT_3 duality between a string theory on AdS_4 x CP^3 and N=6 Chern-Simons reveals intriguing connections relating the latter to N=4 SYM, in a peculiar high spin limit.

Development of an X-ray spectrometric system and feasibility tests of Silicon Drift Detector for medical and space applications.

Lucia Andreani

The thesis work concerns X-ray spectrometry for both medical and space applications and is divided into two sections.

The first section addresses an X-ray spectrometric system designed to study radiological beams and is devoted to the optimization of diagnostic procedures in medicine. A parametric semi-empirical model capable of efficiently reconstructing diagnostic X-ray spectra in 'middle power' computers was developed and tested. In addition, different silicon diode detectors were tested as real-time detectors in order to provide a real-time evaluation of the spectrum during diagnostic procedures. This project contributes to the field by presenting an improved simulation of a realistic X-ray beam emerging from a common X-ray tube with a complete and detailed spectrum that lends itself to further studies of added filtration, thus providing an optimized beam for different diagnostic applications in medicine.

The second section describes the preliminary tests that have been carried out on the first version of an Application Specific Integrated Circuit (ASIC), integrated with large area position-sensitive Silicon Drift Detector (SDD) to be used on board future space missions. This technology has been developed for the ESA project: LOFT (Large Observatory for X-ray Timing), a new medium-class space mission that the European Space Agency has been assessing since February of 2011. The LOFT project was proposed as part of the Cosmic Vision Program (2015-2025).

Implicazioni teoriche e sperimentali della sincronizzazione assoluta nella teoria della relatività speciale

Massimo Brighi

Sono indagate le implicazioni teoriche e sperimentali derivanti dall'assun-zione, nella teoria della relatività speciale, di un criterio di sincronizzazione (detta assoluta) diverso da quello standard.

La scelta della sincronizzazione assoluta è giustificata da alcune considerazioni di carattere epistemologico sullo status di fenomeni quali la contrazione delle lunghezze e la dilatazione del tempo. Oltre che a fornire una diversa interpretazione, la sincronizzazione assoluta rappresenta una estensione del campo di applicazione della relatività speciale in quanto può essere attuata anche in sistemi di riferimento accelerati. Questa estensione consente di trattare in maniera unitaria i fenomeni sia in sistemi di riferimento inerziali che accelerati.

L'introduzione della sincronizzazione assoluta implica una modifica delle trasformazioni di Lorentz. Una caratteristica di queste nuove trasformazioni (dette inerziali) è che la trasformazione del tempo è indipendente dalle coordinate spaziali.

Sulla base delle trasformazioni inerziali si derivano le trasformazioni per i campi elettromagnetici e le equazioni di questi campi (che sostituiscono le equazioni di Maxwell). Si mostra che queste equazioni contengono soluzioni in assenza di cariche che si propagano nello spazio come onde generalmente anisotrope in accordo con quanto previsto dalle trasformazioni inerziali. L'applicazione di questa teoria elettromagnetica a sistemi accelerati mostra l'esistenza di fenomeni mai osservati che, pur non essendo in contraddizione con la relatività standard, ne forzano l'interpreta-zione. Viene proposto e descritto un esperimento in cui uno di questi fenomeni è misurabile.