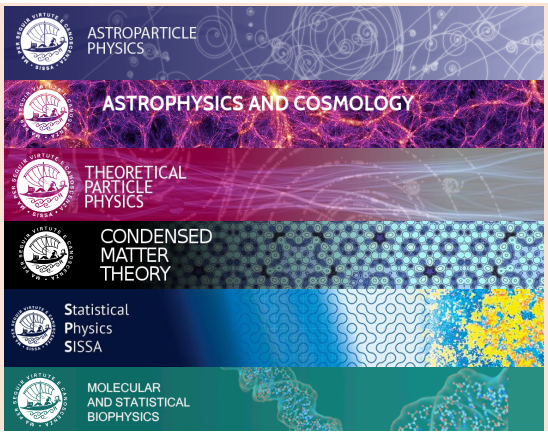
SISSA

INTRA-AREA MEETING **PHYSICS**



2019 December 13th – Building A – Room 128/129

8h50 – 9h00 : OPENING (Stefano LIBERATI)

9h00 – 10h00	**APC**	Coordinator Intro (Andrea LAPI) Anna FELTRE – DISTANT GALAXIES UNDER SCRUTINY Pauline VIELZEUF – STUDYING COSMIC VOIDS IMPRINTS IN THE CMB RADIATION
10h00 – 11h00	**APP**	Coordinator Intro (Matteo VIEL) Raul CARBALLO-RUBIO - BLACK HOLES AT A CROSSROAD Titouan LAZEYRAS - TOWARDS AN ACCURATE MODELLING OF THE LARGE-SCALE STRUCTURE OF THE UNIVERSE
11h00 – 11h30		Coffee Break
11h30 – 12h30	**CM**	Coordinator Intro (Massimo CAPONE) Maria Florencia LUDOVICO - THE EFFECT OF COULOMB INTERACTIONS ON ENERGY CONVERSION PROCESSES IN NANOSTRUCTURES Federico GRASSELLI - QUANTIZATION AND GAUGE INVARIANCE OF CHARGE TRANSPORT IN INSULATING FLUIDS
12h30 – 14h30		Lunch
14h30 – 15h30	**SBP**	Coordinator Intro (Giovanni BUSSI) Irene ADROHER-BENITEZ - POLYMERS FOR LIFE Mattia BERNETTI – COMBINING MOLECULAR DYNAMICS SIMULATIONS WITH SOLUTION EXPERIMENTS TO CHARACTERIZE RNA CONFORMATIONAL
15h30 – 16h00		Coffee Break
16h00 – 17h00	**SP**	Coordinator Intro (Pasquale CALABRESE) Raul ARIAS - ENTANGLEMENT HAMILTONIANS Gabriele PERFETTO - NON-EQUILIBRIUM DYNAMICS OF ONE-DIMENSIONAL QUANTUM SYSTEMS WITH CONFINED EXCITATIONS
17h00 – 18h00	**TPP**	Coordinator Intro (Giulio BONELLI) Dave SUTHERLAND - LOOKING FOR HEAVY NEW PARTICLES IN IGNORANCE Lorenzo UBALDI - BEYOND THE STANDARD MODEL OF PARTICLE PHYSICS

Coordinator Intro: 10min – Contributions: 20min + 5min

SISSA – Scuola Internazionale Superiore di Studi Avanzati , via Bonomea 265, 34136 Trieste

Local Organisation Committee

Mario COLLURA
Stefano LIBERATI

Scientific Committee

Giulio BONELLI
Giovanni BUSSI
Pasquale CALABRESE
Massimo CAPONE
Mario COLLURA
Andrea LAPI
Stefano LIBERATI
Matteo VIEL

Contributions

Astrophysics and Cosmology (APC)
Speaker: Anna FELTRE
Title: DISTANT GALAXIES UNDER SCRUTINY
Abstract: High-quality spectra from modern ground-based spectrographs are providing just now the first glimpse of distant galaxies. At the same time, significant effort has focused on the development of theoretical spectra models tailored to the interpretation of these spectra. I will show how spectral model predictions, combined with innovative observations, can help us gain new insights into the nature of the ionizing radiation and the physical conditions of the interstellar medium of distant galaxies. I will also highlight successes and limitations of spectral models, as learned from lessons on analogs of primeval galaxies, along with perspective for future improvements.

Speaker: Pauline VIELZEUF
Title: STUDYING COSMIC VOIDS IMPRINTS IN THE CMB RADIATION
Abstract: Along with galaxies, galaxy clusters and filaments, cosmic voids are known as key elements that forms our late universe. They are observed thanks to galaxy surveys that aim to map this so-called cosmic web. Due to their large size (~ tens of Mpc/h) cosmic voids have been for a while complicated statistical probes. However, new generation surveys are now covering a large enough area that allows us to use them as cosmological probe. On top of it, the radiation that we received from the primordial universe, the cosmic microwave background (CMB), will be deflected by the matter field it crosses before reaching us. The correlations between the late universe and the primordial radiation is thus a source of cosmological information, and I will expose how to detect and study such correlations.

Astroparticle Physics (APP)

Speaker: Raul CARBALLO-RUBIO
Title: BLACK HOLES AT A CROSSROAD
Abstract: We are living exciting times in the field of black hole physics. The two known long-range fundamental interactions, gravitational and electromagnetic, are being used to explore the properties of astrophysical black holes as never before. Theoretical research is also advancing at a rapid pace. One of the most fundamental questions that remain to be answered, namely the fate of singularities inside black holes, is certainly the most controversial one. Numerous theoretical models are being developed independently by different groups. These two worlds are bound to collide soon, as observations will become precise enough to start testing the boldest theoretical proposals. In this talk, I will summarize these developments and their possible future ramifications.

Speaker: Titouan LAZEYRAS
Title: TOWARDS AN ACCURATE MODELLING OF THE LARGE-SCALE STRUCTURE OF THE UNIVERSE
Abstract: In the last century, Cosmology evolved from a speculative field to a high-precision science. In this new era, the study of the Large-Scale Structure of the Universe takes an increasingly bigger place with several current and future galaxy surveys allowing us to measure the position of millions and millions of galaxies, which encapsulates a wealth of cosmological information. In order to extract this information in an unbiased way, an accurate theoretical modelling of the Large-Scale structure is required. A crucial point is the link between the distribution of luminous tracers (such as galaxies) and that of the underlying mysterious dark matter, which is the focus of the so-called bias formalism. In this talk I will review basics of structure formation in

the Universe and discuss the bias formalism, as well as their implication for galaxy surveys.

Theory and Numerical Simulation of Condensed Matter (CM)

Speaker: Maria Florencia LUDOVICO

Title: THE EFFECT OF COULOMB INTERACTIONS ON ENERGY CONVERSION PROCESSES IN NANOSTRUCTURES

Abstract: The understanding and description of transport and energy conversion processes in nanoscale devices is crucial for the development of novel nanotechnologies, such as, the implementation of quantum machines or heat diodes among others. In particular, the manipulation of charge and energy fluxes and the control of energy dissipation are strategic tasks for designing energy-efficient circuits. Nanostructures working at low temperatures as, for example, quantum dots, are perfect candidates because the energy-filter effect is maximized by the discrete energy spectrum and their tuneable electronic and optical properties. Both the presence of Coulomb interactions and the application of time-dependent gate voltages were separately reported as routes for boosting the efficiency of the circuits. Nevertheless, collective phenomena effects in time-dependent driven systems are still less explored due to the challenges and numerical costs implied by the theoretical descriptions. In this direction, extensions to the non-stationary case of slave-particles techniques turn out to be simple and efficient semianalytical frameworks for describing the dynamics of interacting systems. Particularly, in this talk, I would like to briefly introduce you a pragmatical way to apply the slave-boson approach in the case of adiabatically driven systems, in which the full dynamics is described in terms of equilibrium solutions at every instant of time. Moreover, I will present some results on the performance of quantum-dot-based nanomotors.

Speaker: Federico GRASSELLI

Title: QUANTIZATION AND GAUGE INVARIANCE OF CHARGE TRANSPORT IN INSULATING FLUIDS

Abstract: Charge transport is observed in electronically gapped fluids, such as molten salts, where the ionic diffusion leads to a non-vanishing static electrical conductivity even in the absence of conducting electrons. From the theoretical standpoint, the electrical conductivity can be extracted from the time-correlation function of electric currents in equilibrium molecular dynamics simulations, according to the Green-Kubo theory of linear response. Despite the apparent simplicity of a naive classical description - where ions transport an integer, time independent, charge - in a first-principle framework the instantaneous electric currents are obtained from the Born effective charges, which are real, tensor, and time-dependent quantities: a

computationally time-consuming and conceptually abstruse task. Interestingly enough, the same electrical conductivity is exactly obtained if the Born tensors are replaced by the integer oxidation numbers of the atoms. In this talk we discuss how the gauge-invariance principle of transport coefficients can be combined with arguments from charge-transport quantization to understand such unexpected coincidence, providing a formal, quantum mechanical definition of oxidation states in liquid insulators, and an alternative method to compute first-principle electrical conductivity of ionic fluids. Examples and numerical experiments are given for the case of molten potassium chloride

Molecular and Statistical Biophysics (SBP)

Speaker: Irene ADROHER-BENITEZ
Title: POLYMERS FOR LIFE
Abstract: Polymers are widely known systems because of the large number of applications they have in industry and in our every day life. Even though when talking about them we usually think about plastics, these long molecules are incredibly versatile and may play a important role in many fields of science. For instance, complex structures can be assembled from single chains, building larger systems such as polymer brushes, branching polymers, or (macro/micro) gels, which can be targeted towards different biomedical applications. Moreover, polymers are also present in nature in many ways. In particular, we are interested in the longest biopolymer in our body: DNA. Inside the nucleus of each human cell there is around two meters of DNA organized into structures called chromosomes. The behaviour of these molecules is the result of a complex interplay of physics and chemical reactions, but studying the system from a polymer physics perspective can help us to understand the spatial architecture and dynamics of these systems essential to our lives.

Speaker: Mattia BERNETTI
Title: COMBINING MOLECULAR DYNAMICS SIMULATIONS WITH SOLUTION EXPERIMENTS TO CHARACTERIZE RNA CONFORMATIONAL DYNAMICS
Abstract: RNA biomolecules are crucial actors in the cellular machinery. Besides permitting the flow of genetic information from the DNA to functional proteins, it is now clear that they also play active roles in regulation and signaling processes. To this end, they must interact with biological partners through the adoption of well-defined structures. Thus, thoroughly understating their functions implies a detailed characterization of their structural features. Despite fluorescence spectroscopy and small-angle x-ray scattering (SAXS) experiments allow obtaining precious structural insights, their outcome data are generated as time and ensemble averages and produce low resolution information. Therefore, integrating the available data with an atomic-level outlook, as provided by molecular dynamics (MD) simulations, can be of

striking support. Here, we explore such framework to characterize the structural dynamics of the GTPase-associated center (GAC), a biologically relevant RNA involved in protein translation.

Statistical Physics (SP)

Speaker: Raúl ARIAS
Title: ENTANGLEMENT HAMILTONIANS
Abstract: I will shortly introduce the notion of entanglement (Modular) Hamiltonians and their uses in different areas of theoretical physics like quantum information, Quantum Field theory and Gravity. I will review as well some known results and some ongoing related projects.

Speaker: Gabriele PERFETTO
Title: NON-EQUILIBRIUM DYNAMICS OF ONE-DIMENSIONAL QUANTUM SYSTEMS WITH CONFINED EXCITATIONS
Abstract: Confinement is a fundamental concept in high energy physics, but it is also present in one-dimensional quantum many body systems. In the talk I will discuss how confinement of quasi-particle excitations arises in the latter class of systems and how it dramatically affects the non-equilibrium real time dynamics causing severe suppression of quantum correlation spreading and of entanglement growth and long-time persistence of spatial inhomogeneities. I will then show how a unified framework of this anomalous dynamics can be obtained in terms of effective Hamiltonians exhibiting Stark localization and how this slow dynamical behavior is related to the Schwinger effect of quantum electrodynamics. These results are obtained for the quantum Ising spin chain with both transverse and longitudinal magnetic fields but they can be applied to lattice gauge theories as well since they rely solely on the presence of confinement.

Theoretical Particle Physics (TPP)

Speaker: Dave SUTHERLAND
Title: LOOKING FOR HEAVY NEW PARTICLES IN IGNORANCE
Abstract: One pressing question in the field of particle physics is: after the Higgs boson, what, if any, new fundamental particles remain to be discovered (at collider experiments such as the LHC, and elsewhere)? I will describe how we are returning to the basics of field and scattering theory to develop more holistic, model independent searches for the effects of heavy new particles, and the recent mathematical/computational developments that have made this possible.

Speaker: Lorenzo UBALDI

Title: BEYOND THE STANDARD MODEL OF PARTICLE PHYSICS

Abstract: The Standard Model (SM) of Particle Physics describes the known elementary particles and their interactions, but leaves some important questions unanswered: Why are the weak scale and the Higgs boson's mass small compared to the Planck mass? How do neutrinos get their mass? Why strong interactions do not violate parity? What is the dark matter? After I brief introduction to the SM, I will address these questions.