VII Leopoldo García-Colín Mexican Meeting on Mathematical and Experimental Physics

Report of Contributions

https://sandbox.getindico.io/e/1218

Contribution ID: **1** Type: **not specified**

CLAUS LÄMMERZAHL: Accretion disks as probes of Black Hole physics

Monday, 17 February 2020 11:30 (1 hour)

With accretion discs one can probe the strong gravity regime in the near vicinity of Black Holes. In this talk the general formalism for accretion disks in stationary axially symmetric Black Hole space-times is developed. In the case of matter models based on ideal fluids analytic solutions fort the density and pressure can be found. The formalism can be extended to charged fluids. In addition, also the issue of viscosity will be addressed.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **2** Type: **not specified**

DEIRDRE SHOEMAKER: Numerical Relativity in the Age of Gravitational Wave Observations

Monday, 17 February 2020 12:30 (1 hour)

The advent of gravitational wave astronomy has created opportunities to probe strong-field gravity as black holes merge. Numerical relativity provides the means to confront the measurements with theoretical prediction from general relativity, allowing us to interpret the sources of gravitational waves and to test whether general relativity is the theory governing these events. This talk will talk about what demands will be placed on this field to maximize the science output of the new era.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **3** Type: **not specified**

HERNANDO QUEVEDO: Geometrodynamics of Black Holes

Monday, 17 February 2020 16:00 (30 minutes)

I present the fundamentals of geometrothermodynamics (GTD), a formalism that represents in an invariant way thermodynamic laws and properties in terms of geometric concepts. The GTD of black holes is considered as a particular example and it is shown that a Legendre invariant metric, in which the mass, angular momentum and electric charge are considered as coordinates, can be used to describe the equilibrium space of black holes. As a consequence, black hole phase transitions can be described as curvature singularities of the equilibrium space. Moreover, GTD implies that black holes should be considered as quasi-homogeneous systems and, therefore, additional physical quantities like the cosmological constant should be considered as thermodynamic variables.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **4** Type: **not specified**

NORA BRETÓN: Regular Black Holes

Monday, 17 February 2020 16:30 (30 minutes)

In this talk I address Regular Static Spherically Symmetric Black Holes (BH) constructed by introducing a de Sitter core, like the Hayward BH (HBH), then I compare the different trajectories in free fall, in the interior of the horizon, between a regular (HBH) and a singular (Reissner-Nordstrom) BH; the energy conditions are discussed as well as for the Regular Black Holes sourced by nonlinear electrodynamics (NLED).
Finally, I give some comments on the procedure by Newman-Janis(NJ) to obtain stationary Regular BH starting from a static one, adding some words on the failure of the NJ technique.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **5** Type: **not specified**

ROBERTO SUSSMAN: Towards a relativistic covariant interpretation of Milgrom's acceleration

Monday, 17 February 2020 17:00 (30 minutes)

We propose in this letter a relativistic coordinate independent
interpretation for Milgrom's acceleration $a_0 = 1.2\times10^{-8}\mathrm{cm/s}^2$ through a geometric constraint obtained from the product of the Kretschmann invariant scalar times the surface area of 2–spheres defined through suitable characteristic length scales for local and cosmic regimes, described by Schwarzschild and Friedman–Lemaître–Robertson–Walker (FLRW) geometries, respectively. By demanding consistency between these regimes we
obtain an appealing expression for the empirical (so far unexplained) relation between the accelerations a_0 and cH_0. Imposing this covariant geometric criterion upon a FLRW model, yields a dynamical equation for the Hubble scalar whose solution matches, to a very high accuracy, the cosmic expansion rate of the ΛCDM concordance model fit for cosmic times close to the present epoch. While these results are very preliminary and strictly valid only at a toy model level, we believe that they could provide relevant information in the search of alternative gravity theories or even within General Relativity itself.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **6** Type: **not specified**

JORGE CERVANTES-COTA: A Brief History of Gravitational Waves

Tuesday, 18 February 2020 11:30 (1 hour)

This review describes the discovery of gravitational waves. We recount the journey of predicting and finding those waves, since its beginning in the early twentieth century, their prediction by Einstein in 1916, theoretical and experimental blunders, efforts towards their detection, and finally the subsequent successful discovery.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **7** Type: **not specified**

OMAR LÓPEZ-CRUZ: Optical Follow-up of Gravitational Wave Sources

Tuesday, 18 February 2020 12:30 (1 hour)

Detecting the electromagnetic (EM) counterpart of gravitational waves (GW) sources gives us with a wealth of information to understand the properties of the GW precursors. The fusion of neutron stars (NS) binaries has been identified as sources of GW. NS-NS fusions are also strong sources of EM radiation,they are called kilonovae. The light produced by kilonovae is mostly red, due to the high opacity of f-shell lanthanide-group elements, and broad spectroscopic features, resulting from the high velocities and many atomic transitions of the heavy r-process elements can be seen. Optical observations also provide information about outflows. In this talk I review what we have learned about the GW170817 event. I also describe the follow-up program of LIGO-VIRGO events using optical telescopes in Mexico, Spain, Chile, Argentina and United States.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **8** Type: **not specified**

CARLOS HERDEIRO: Black holes and ultralight bosonic fields

Wednesday, 19 February 2020 11:30 (1 hour)

Hypothetical ultralight bosonic particles have been suggested as (fuzzy) dark matter candidates. Such particles will spontaneously form macroscopic bosonic halos around spinning astrophysical black holes (BH), via an energy extraction process called superradiance, transferring part of the mass and angular momentum of the BH into the halo. I consider the phenomenology of this process, and of the equilibrium state attained. The latter is metastable. It may decay via gravitational wave emission, or via the growth of new superradiant modes. I discuss the opportunities to test these models with Gravitational Wave searches or black hole imaging. I also discuss the dynamics of relativistic bosonic stars, that describe self-gravitating lumps of these ultralight bosonic particles.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **9** Type: **not specified**

VOLKER PERLICK: Influence of a cosmic expansion on the shadow of a black hole

Wednesday, 19 February 2020 12:30 (1 hour)

If a black hole is seen against a backdrop of light sources, it shows a black disc known as the "shadow" of the black hole. In the first part of the talk I recall how the boundary curve of the shadow can be analytically calculated for an isolated (Schwarzschild or Kerr) black hole. Then I discuss how the cosmic expansion, in the simplest case just driven by a cosmological constant, would influence the size of the shadow and if this influence could be of any relevance for actual observations of black-hole shadows.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **10** Type: **not specified**

DENNIS PHILIPP: General Relativistic Geodesy: concepts and effects

Wednesday, 19 February 2020 16:00 (30 minutes)

The Earth's geoid is one of the most important fundamental concepts to provide a gravity field-related height reference in geodesy and associated sciences. To keep up with the ever-increasing experimental capabilities and to consistently interpret high-precision measurements without any doubt, a relativistic treatment of geodetic notions (including the geoid) within Einstein's theory of General Relativity is inevitable.
Building on the theoretical construction of isochronometric surfaces and the so-called redshift potential for clock comparison, we define a relativistic gravity potential as a generalization of known (post-)Newtonian notions. This potential exists for any stationary configuration and observers who rigidly co-rotate. It is the same as realized by local plumb lines. In a second step, we employ this gravity potential to define the relativistic geoid in direct analogy to the Newtonian understanding. In the respective limits, it allows to recover well-known (post-)Newtonian results. However, the framework does not involve any approximation regarding the field strength and we can, thus, also speak of the geodesy of other (compact) objects.
Further generalizations such as relativistic normal gravity, height measures, and the proper time of observers on the geoid w.r.t. IAU resolutions will be discussed as well. To illustrate the concepts, some particular exact solutions of Einstein's field equation as well as a parametrized post-Newtonian metric will be investigated. Moreover, a comparison to the Newtonian results sheds light on the magnitude of relativistic effects.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **11** Type: **not specified**

ELÍAS CASTELLANOS: Bose-Einstein condensates as dark matter halos

Wednesday, 19 February 2020 16:30 (30 minutes)

Scalar Fields in the form of Bose-Einstein condensates (BEC's), seem to be a good candidate to describe dark matter in the universe. Even more, the existence of black holes in the center of some galaxies could be astrophysical phenomena that lead to the so-called quasi-bound states for the condensate that, in this scenario, can be interpreted as a galactic dark matter halo. By using the Thomas-Fermi approximation, we analyze the density distribution of the condensate in a Schwarzschild black hole space time, which we assumed as the BEC-dark matter halo. Additionally, from a simple and concise form we are able to confront the predictions of the Tomas-Fermi approximation with some data of rotation curves in galaxies. We set constraints on the parameters related to the halo, i.e., the mass parameter, the self-interaction coupling constant and the mass of the black hole (the only astrophysical parameter). We found that we could have a good fitting to the galaxies rotation curve, making to the Bose-Einstein condensate model a strong candidate to explain the fundamental nature of dark matter.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **12** Type: **not specified**

HUGO MORALES-TÉCOTL: Polymer Quantum Field Theory in the High Energy Regime

Wednesday, 19 February 2020 17:00 (30 minutes)

The proposal of loop (polymer) quantization of general relativity can be adapted to systems with finite number of degrees of freedom like each one of the infinite modes (harmonic oscillators) forming a scalar field to give rise to the Hosain-Husain-Seahra (HHS) model. This model crucially relies on the properties of the Mathieu solutions of the quantum pendulum that corresponds to the polymer oscillators and its generalization to interacting field theories is difficult. In this work we provide a a different perspective of the HHS model based on Feynman approach within the polymer scheme that relies on a perturbative expansion valid for high energies and which is amenable to include interactions.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **13** Type: **not specified**

ROMÁN LINARES: α' corrections of Black Holes

Wednesday, 19 February 2020 18:00 (30 minutes)

In this talk we review some characteristics of the α' corrections of black holes in the context of Heterotic Superstring effective field theory. In particular we will discuss the corrections to non-extremal 4-dimensional dyonic Reissner-Nordström Black Holes. We argue that to first order in α', consistency with the equations of motion of the Heterotic Superstring demands additional scalar and vector fields become active. We determine analytically the position of the event Horizon of the black hole, as well as the corrections to the extremality bound, to the temperature and to the entropy, checking that they are related by the first law of black holes thermodynamics.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **14** Type: **not specified**

MARIO RODRÍGUEZ-MEZA: A code for perturbation theory in modified gravity

Wednesday, 19 February 2020 18:30 (30 minutes)

In this work we present a new code to study perturbation theory in modified gravity. The code is based on the computation of the Lagrangian Perturbation Theory (LPT) kernels. From these kernel functions we can compute the correlation function in Convolution-LPT (CLPT) and the power spectrum in Standard Perturbation Theory (SPT). We applied the code to compute the correlation function in CLPT and the power spectrum in SPT for LCDM, f(R) Hu-Sawicky and DGP braneworld models. We have made public the code to compute these statistics.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **15** Type: **not specified**

MARIO C. DÍAZ: How heavy are stellar mass black holes?

Thursday, 20 February 2020 11:30 (1 hour)

Very soon the gravitational wave ground based detectors will hit the 50 binary Black Hole mergers detection milestone. This means that in less than five years, our knowledge about the existence of BHs have increased fivefold compared to what we have learned in the previous 40 years before the first gravitational wave detection.
What have we learned from gravitational wave astronomy about their masses? How is this knowledge constraining stellar evolution and what we know about it?
In this talk I will present a review of the detections (and detection candidates -alerts-) made by gravitational wave detectors, compare it with our knowledge from electromagnetic astronomy and discuss the implications for theories of stellar evolution.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **16** Type: **not specified**

STEFANIE KOMOSSA: The quest for supermassive black holes: singles, binaries, and mergers

Thursday, 20 February 2020 12:30 (1 hour)

Supermassive black holes with their extreme gravitational fields are at the forefront of research in extragalactic astrophysics. This talk outlines some of the major discoveries in black hole astrophysics, from early ideas to the most recent breakthroughs.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **17** Type: **not specified**

ANTONIO GARCÍA: Relativistic Runge-Lenz Vector

Thursday, 20 February 2020 16:00 (30 minutes)

We consider the construction of a S0(4) scalar field theory non minimally coupled to a Couloumb potential. Using the symmetry we calculate the hydrogen atom spectrum. We find that the symmetry have among its generators a constant of motion that we can identify with a Relativistic Runge-Lenz vector.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **18** Type: **not specified**

YURI BONDER: Symmetries in theories with nondynamical fields

Thursday, 20 February 2020 16:30 (30 minutes)

I will first present a formalism to study symmetries in the context of diffeomorphism-invariant gauge theories. With it, I will show a universal symmetry algebra that contains the gauge symmetry and a covariant version of the diffeomorphisms. Then, I will include nondynamical fields that are supposed to describe effects associated with more fundamental degrees of freedom. Typically, these objects reduce/break the symmetries of the theory, and I will present a method to find the residual symmetries. I will present some results obtained with this method in theories with explicit Lorentz invariance and for the Unimodular Theory of Gravity, which is only invariant under a subgroup of diffeomorphisms.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **19** Type: **not specified**

MARCO MACEDA: Noncommutative inspired black holes

Thursday, 20 February 2020 17:00 (30 minutes)

We review the idea of noncommutative smeared distributions of mass and charge as a tool for the construction of noncommutative inspired black holes. These solutions are free of singularities and possess interesting properties; using them, we discuss some of their applications in different physical scenarios.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **20** Type: **not specified**

DAVID VERGARA: Quantum Geometry from a Noncommutative C*-twisted Poincaré algebra

Thursday, 20 February 2020 18:00 (30 minutes)

We investigate a quantum geometric space in the context of what could be considered an emerging effective theory from quantum gravity. Specifically we consider a two-parameter class of twisted Poincaré algebras, from which Lie-algebraic noncommutativities of the translations are derived as well as associative star-products, deformed Riemannian geometries, Lie-algebraic twisted Minkowski spaces, and quantum effects that arise as noncommutativities. Applying the GNS construction we derive the extremal pure states and corresponding local convexes and combined convex hull and we describe the associated topological structure of the convex hull.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **21** Type: **not specified**

MIGUEL SABIDO: Noncommutative Cosmology and the Cosmological Constant

Thursday, 20 February 2020 18:30 (30 minutes)

In this work we explore the possibility of a noncommutative origin to the cosmological constant. The results are derived in the context of noncommutative cosmology, where noncommutativity is introduced by a deformation on the minisuperspace variables. These ideas are explored in several examples, the main result is an effective cosmological constant in terms of the deformation parameters.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **22** Type: **not specified**

HUGO COMPEÁN: Deformation quantization of superstrings

Thursday, 20 February 2020 19:00 (30 minutes)

In this work the quantization of the superstring is performed via the deformation quantization formalism in the Neveu-Schwarz- Ramond approach. We use the Weyl-Wigner-Moyal-Groenewold formalism to carry out the quantization. The Stratonovich-Weyl operator, the Moyal star product and the Wigner function of the ground state for the superstring are obtained. The spectrum of states is also obtained in the light-cone gauge of the superstring. Finally we give some remarks of a generalization to string field theory.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **23** Type: **not specified**

FRANCISCO TURRUBIATES: Uncertainty relations in arbitrary phase spaces

Thursday, 20 February 2020 19:30 (30 minutes)

Uncertainty relations define one of the main differences between classical mechanics and quantum mechanics and are of fundamental importance in the description of quantum systems. In this talk the construction of uncertainty relations for systems with arbitrary phase spaces by means of deformation quantization formalism is discussed. In particular, the expressions of the so-called Heisenberg-Robertson and Robertson-Schrödinger uncertainty relations for an arbitrary number of observables are obtained. Finally, the conditions to minimize Robertson-Schrödinger's uncertainty relations are analyzed, which allows us to introduce the concept of intelligent states in deformation quantization.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **24** Type: **not specified**

FRANCISCO GUZMÁN: Estimates of black hole parameters in astrophysical systems

Friday, 21 February 2020 16:00 (30 minutes)

We describe the inverse method approach to determine parameters of astrophysical systems involving black holes. In the first case we review the reconstruction of binary black hole parameters out of the gravitational wave signal. In a second case we estimate parameters of a black hole out of the image observed, produced by matter around the black hole. In the two scenarios we describe the state of the art in the solution of the direct problem and the consequent complexity of the future challenges of the resulting inverse problems.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **25** Type: **not specified**

DANIEL SUDARSKY: A novel account for the nature and magnitude of the Dark Energy

Friday, 21 February 2020 16:30 (1 hour)

I will discuss some ideas about the interface between the quantum and gravitational realms, and the emergence of space-time itself, which led us to specific speculations about the way in which anticipated discrete aspects of quantum gravity might become manifest at the macroscopic level. We then will discuss an alternative description of gravitation, initially explored by Einstein, and known as Unimodular Gravity which can, under suitable conditions, incorporate such novel effects. The result is a mechanism for the generation an effective cosmological constant, that turns out to be naturally of the same order of magnitude as that dictated by observations. If this turns out to be correct the empirical case for the presence of a dominant dark energy component in the present day universe would turn out to be the first concrete evidence of a discreetness in the fabric of space-time. I will end with some comments about how the approach might also help in resolving the so called " H_0 tension".

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **26** Type: **not specified**

PABLO LAGUNA: Space-time Curiosities: Inside the Final Black Hole and Geometrorobotics

Friday, 21 February 2020 11:30 (1 hour)

Modeling black hole as punctures in space-time is common in binary black hole simulations. As the punctures approach each other, a common apparent horizon forms, signaling the coalescence of the black holes and the formation of the final black hole. In the first part of the talk, I will present results about the fate of the merging punctures inside the final black hole. While most studies of locomotion treat the environment and the locomotor separately, there exist a class of self-propelled systems which change the environment so dramatically that a treatment of them as a single entity is more natural. In the second part of the talk, I will present results from a study of the dynamics of a robophysical car driving around a central depression in a deformable membrane showing that the robot propulsion can be recast as geodesics of a test particle in a fiducial space-time.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **27** Type: **not specified**

MIGUEL ALCUBIERRE: Gravitational waves

Friday, 21 February 2020 12:30 (1 hour)

The theory of General relativity was postulated by Albert Einstein at the end of 1915. One of its main predictions was the existence of gravitational waves, that is perturbations of the geometry of space-time that travel at the speed of light, and are produced by violent astrophysical phenomena, sus as supernova explosions or the collisions of compact objects. However, gravitational waves are generally so weak that it took over a hundred years to detect them. The first confirmed detection happened in September 2015 at the Laser Interferometer Gravitational Observatory (LIGO), and was identified as the collision of two black holes. The 2017 Nobel Prize was awarded to three scientists for their crucial contribution to the development of LIGO. To date, 10 such detections have been confirmed, and there are over 20 new candidate events. At the end of 2017 the first detection of the collision of two neutron stars was announced, which coincided with a detection of a gamma ray burst, and was subsequently observed in the whole electromagnetic spectrum by many observatories both in space and around the world. In this talk I will give a brief introduction to the concept of gravitational waves, as well as the exiting results related to the first detections and the Nobel Prize.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **28** Type: **not specified**

REMO RUFINI: Discovery of energy extraction by discrete ”Black-Holic” quanta from a Kerr Black Hole in GRB 190114C

Monday, 17 February 2020 10:00 (1 hour)

Almost fifty years after the paper “Introducing the Black Hole” by Ruffini and Wheeler and the Black Hole (BH) mass energy formula by Christodoulou Ruffini and Hawking, we can finally assert that we have been observing the moment of creation of a BH in the BdHN I GRB 190114C with corresponding rotational energy extraction process. The predicted properties of the BdHN I have been now observed: both in this source and in GRB 130427A, in GRB 160509A and in GRB 160625B. The first appearance of the Supernova the SN rise triggering the BdHN has been identified and followed all the way to the appearance of the optical SN. The onset of the GeV radiation coinciding with the BH formation has revealed self similar structures in the time resolved spectral analysis of all sources. Consequently, we find evidence for quantized-discrete-emissions in all sources, with energy quanta of 1037 ergs with repetition time of 10-14 sec. GRBs are the most complex systems ever successfully analyzed in physics and astrophysics, and they may well have a role in the appearance of life in the Cosmos. These results have been made possible by a long-lasting theoretical activity, a comprehensive unprecedented high quality data analysis, an observational multi-messenger effort by the astronomical, the physical and the space research communities. This observational effort is well epitomized by the original Vela Satellites, the NASA Compton space mission (CGRO), the Italo-Dutch Beppo SAX satellite, The Russian Konus Wind Satellite, the NASA Niels-Gehrels SWIFT satellite, the Italian AGILE satellite, the NASA FERMI mission and most recently the Chinese satellite HXMT. These space missions have been assisted by radio and optical equally outstanding observational facilities from the ground.

Session Classification: SUPER PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **29** Type: **not specified**

HEINO FALCKE: Imaging Black Holes with the Event Horizon Telescope

Thursday, 20 February 2020 10:00 (1 hour)

One of the most fundamental predictions of general relativity are black holes. Their defining feature is the event horizon, the surface that even light cannot escape. When illuminated by ambient light, the event horizon of black holes will cast a dark shadow on the emitting region that is detectable under certain circumstances with global interferometers operating at mm- and submm-wavelengths. Recently the Event Horizon Telescope has detected this shadow feature in the radio galaxy M87, providing a first glimpse at scales surrounding the event horizon. Models invoking general relativity and magnetized plasma hydrodynamics are able to reproduce the appearance of the shadow and of the powerful jet launched at these scales. This provides strong support for the existence of supermassive black holes in the universe and sheds light on how they work. To improve the imaging quality further more telescopes should be added to the array, in particular in Africa. The more distant future will belong to higher frequencies and space-based interferometry. The talk will review the latest results of the Event Horizon Telescope, its scientific implications and future expansions of the array.

Session Classification: SUPER PLENARY TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **30** Type: **not specified**

ALFREDO HERRERA: Estimation of mass and spin parameters of a Kerr black hole: Newton vs. Einstein

Monday, 17 February 2020 18:00 (30 minutes)

A new general relativistic method for estimating the mass and spin parameters of a Kerr black hole (BH) from observational data is presented, i.e. from the red/blueshift of photons emitted by certain bodies orbiting around the BH, and the parameters characterizing their orbits (the radius and the polar angle for generic elliptical trajectories). With this method one can predict, and eventually look for, new relativistic effects related to the curvature of spacetime generated by the mass and the spin of black holes (this is in contrast to the Newtonian approach that is usually used to estimate the mass, for instance). In addition, this method allows us to clearly visualize which Newtonian and general relativistic contributions enter in the expression for the redshifts, and therefore for the mass and the spin parameters. So far we have managed to obtain analytical formulas to calculate both quantities (M and a) in the case of circular orbits that lie in the equatorial or galactic plane. These formulas are relatively simple and can be used very easily in this case. We are currently working on the confrontation with observations of a system that presents the aforementioned characteristics. In the case of more realistic orbits (elliptical orbits that lie outside the equatorial plane), we need to develop the method further. This more refined version of our formalism could be used to make very precise estimations of the parameters that characterize a Kerr black hole hosted in the galactic center of the systems that have been studied so far with the Event Horizon Telescope, in particular that of the Milky Way.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **31** Type: **not specified**

ELOY AYÓN-BEATO: On the consistent thermodynamics of Lifshitz black holes

Monday, 17 February 2020 18:30 (30 minutes)

In arbitrary dimension, we consider a theory described by the most general quadratic curvature corrections of Einstein gravity together with a self-interacting nonminimally coupled scalar field. This theory is shown to admit five different families of Lifshitz black holes dressed with a nontrivial scalar field. The entropy of these configurations is microscopically computed by means of a higher-dimensional anisotropic Cardy-like formula where the role of the ground state is played by the soliton obtained through a double analytic continuation. This involves calculating the correct expressions for the masses of the higher-dimensional Lifshitz black hole as well as their corresponding soliton. The robustness of this Cardy-like formula is checked by showing that the microscopic entropy is in perfect agreement with the gravitational Wald entropy. Consequently, the calculated global charges are compatible with the first law of thermodynamics as well as an anisotropic higher-dimensional version of the Smarr formula. Some of these configurations exist on Lifshitz critical points of the theory where all their extensive thermodynamic quantities vanish.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **32** Type: **not specified**

DANIEL AMARO: Geodesic Structure of the Einstein-Euler-Heisenberg Black Hole Spacetime

Monday, 17 February 2020 19:00 (30 minutes)

We derive the electrically charged static black hole spacetime of the Einstein-Euler-Heisenberg theory, in terms of the Plebański dual variables. This solution is a non-linear electromagnetic generalization of the Reissner-Nordström solution and it is characterized by three parameters: mass M, electric charge Q_e , and Euler-Heisenberg non-linearity parameter A. We study the trajectories of massive (charged and uncharged) and massless test particles in this spacetime. We also study the propagation of light, where the orbits of photons are analyzed by means of the effective Plebański pseudo-metric related to the geometrical metric and to the electromagnetic energy-momentum tensor. The shape of the shadow of the black hole is also presented and discussed.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **33** Type: **not specified**

LEONARDO PATIÑO: Thermodynamics of D7-branes in supergravity warped black holes.

Monday, 17 February 2020 19:30 (30 minutes)

A way to construct a warped black hole in IIB supergravity will be presented. The two parameters that characterize the resulting solution are the size of the horizon and the warping factor. A D7-brane will be embedded in this background in such a way that a particular asymptotic behavior is achieved. Depending on the value of the parameters of the black hole, the embedding of the D7-brane can be of two different types that are distinguish from each other by their thermodynamic properties, corresponding to separate phases of the D7 in this family of backgrounds. The computation of some of the aforementioned thermodynamic quantities will be presented, along with a phase diagram over the parameter space of the black hole.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON BLACK HOLES AND GRAVITATIONAL WAVES

Contribution ID: **34** Type: **not specified**

MARIO DÍAZ: Five years of Gravitational Wave Astronomy: What have we learned and what will we learn in the next five.

Friday, 21 February 2020 18:00 (1 hour)

On September 14, 2015 gravitational waves were detected for the first time when the merger of two Black-Holes was observed by the LIGO observatories. This momentous discovery started a new era for astrophysics. Yet again, on August 17, 2017 another monumental scientific feat thrusted astronomy into a new paradigm: Multimessenger Astronomy was born thanks to the effort of several thousand physicists and astronomers observing the first binary neutron star merger witnessed by our civilization.
In this talk I will review the results that this new astronomy has brought about, the many open questions we face, discuss the challenges we need to tackle as we move into the next phase and speculate about the near future.

Session Classification: PUBLIC LECTURE

Contribution ID: **35** Type: **not specified**

ROBERTO QUEZADA: Dynamics of quantum states in an energy transport model

Friday, 21 February 2020 11:30 (1 hour)

We will discuss the dynamics of quantum states in an energy transport model (photosynthesis) with a generator defined in terms of operators performing transitions between two mutually orthogonal subspaces, similar to birth and death transitions in classical stochastic processes or creation and annihilation operators in the quantum setting. It turns out that any stationary state has a portion supported on the first subspace and the remaining is supported on the orthogonal. Moreover, any state supported on the first subspace is transported to a state whose probability mass is concentrated on the orthogonal and there is an energy gain in the process.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **36** Type: **not specified**

OSCAR ROSAS-ORTIZ: Supersymmetric Approach to Quantum Mechanics

Friday, 21 February 2020 12:30 (1 hour)

The supersymmetric formulation of quantum mechanics is a subject of intense activity in contemporary physics. It is addressed to analyze the spectral properties of exactly solvable potentials as well as to construct new integrable quantum models. In this talk we revisit the progress of such formulation since the introduction of the factorization method by Dirac to the construction of non-Hermitian systems with all-real spectra that may be used to model open quantum systems with balanced gain (acceptor) and loss (donor) profile

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **37** Type: **not specified**

EUSEBIO JUARISTI: Moléculas Quirales en el Espacio y Homoquiralidad en la Tierra

Wednesday, 19 February 2020 19:00 (1 hour)

En los seres vivos que poblamos la Tierra, los aminoácidos que están presentes en las proteínas son de la forma L, mientras que la ribosa y la desoxirribosa, los azúcares que forman parte del esqueleto de los ácidos ribonucleicos, el ARN y el ADN respectivamente, son de la forma D. ¿Cuál es el origen de la homoquiralidad en las biomoléculas, es decir en las moléculas de la vida? ¿Porqué habrá seleccionado la Naturaleza a los L-aminoácidos y a los D-azúcares?
A mediados del siglo XIX, Pasteur postuló la existencia de una "fuerza disimétrica"en la Naturaleza, que da lugar a una tendencia intrínseca y permanente por una quiralidad específica en todas las moléculas del Universo, que da lugar a una diferencia energética fundamental entre enantiómeros. En este contexto, en 1956 se observó que el decaimiento b de los núcleos atómicos viola el principio de paridad; es decir, este proceso no ocurre con la misma probabilidad que su imagen en el espejo. Alternativamente, la homoquiralidad en los sistemas bioquímicos se ha explicado en términos de fenómenos que alteraron accidentalmente la proporción 50:50 de los enantiómeros posibles en aminoácidos y azúcares, conduciendo eventualmente al predominio observado de las formas L y D, respectivamente.
En este contexto, algunos descubrimientos recientes apoyan la teoría de que la homoquiralidad de las biomoléculas esenciales se originó en eventos extraterrestres.
Sin embargo, se ha encontrado que los excesos enantioméricos producidos por la luz circularmente polarizada en moléculas quirales tales como los aminoácidos (como los detectados en el meteorito de Murchison) son generalmente muy pequeños, por lo que la naturaleza requirió necesariamente de mecanismos químicos para incrementar la pureza enantiomérica de las biomoléculas relevantes. En este sentido, la autocatálisis asimétrica puede dar lugar a una amplificación de la quiralidad.

Session Classification: PUBLIC LECTURE

Contribution ID: **38** Type: **not specified**

SVEN REICHENBERGER: Fundamentals, Scalability and Application of Colloidal Metal and Alloy Nanoparticles prepared by Laser Synthesis and Processing in Liquid.

Tuesday, 18 February 2020 10:00 (1 hour)

*sven.reichenberger@uni-due.de

The availability of laser-generated nanomaterials with gradually tuned intrinsic application-relevant properties (e.g. nanoparticle size, loading, alloy composition) and high purity allowed to systematically study and tailor materials for heterogenous catalysis, additive manufacturing and biotechnology in the recent decade. The scalable, surfactant-free laser-based synthesis route has shown to complement conventional preparation methods of nanomaterials, enabling independent studies in terms of nanoparticle purity, functional properties (size, morphology, oxidation state) and material design (multi-elemental composition) as summarized in Fig. 1.[1,2] Furthermore, preadjusted nanoparticle properties are maintained due to subsequent nano integration onto support materials without any calcination or activation being required (since no surfactants were used in the first place), therefore allowing mechanistic studies while avoiding cross-correlations (e.g. introduced by calcination or changing particle size).[3]

The presented talk intends to cover the fundamentals of surfactant-free laser-based synthesis hierarchically addressing the role of plasma dynamics, cavitation bubble dynamics and the role of persistent micro bubbles as well as laser properties in this context on the nanoparticle productivity and yielded particle size.[4] The previous will be discussed in terms of noble metal, alloy (here mainly Au, Pd, Pt and related alloys) and oxide nanoparticles.[1] Recent advances in scale-up allowing the g/h-synthesis and posttreatment of nanoparticles, as well as continuous preparation of catalysts up to several 10th of kg per 40h week, will be demonstrated.[5] Finally, newest advances in pulsed laser post-processing and related laser-based defect-engineering of semiconductor and spinel materials, its feasibility and perspectives in fundamental catalytic studies will be discussed.[6]

Acknowledgments:
The author gratefully acknowledges funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) –Projektnummer 388390466 –TRR 247

References

[1] S. Reichenberger, G. Marzun, M. Muhler, S. Barcikowski, ChemCatChem. 2019, 11 (18), 4489
[2] D. Zhang, B. Gökce, S. Barcikowski, Chemical Reviews 2017, 117, 3990.
[3] a) G. Marzun, A. Levish, V. Mackert, T. Kallio, S. Barcikowski, P. Wagener, J. Coll. Int. Sc. 2017, 489, 57. // b) Dong, W. ; Reichenberger, S. ; Chu, S. ; Weide, P. ; Ruland, H. ; Barcikowski, S. ; Wagener, P. ; Muhler, M. Journal of Catalysis 330 (2015), S. 497-506
[4] a) C. Y. Shih, R. Streubel, J. Heberle, A. Letzel, M. V. Shugaev, C. Wu, M. Schmidt, B. Gökce, S. Barcikowski, L. V. Zhigilei, Nanoscale (2018), 10, 6900–6910. // b) S. Reich, A. Letzel, A. Menzel, N. Kretzschmar, B. Gökce, S. Barcikowski, A. Plech, Nanoscale (2019), 11, 6962–6969. // M. R. Kalus, V. Reimer, S. Barcikowski, B. Gökce, Appl. Surf. Sci. (2019), 465, 1096–1102.
[5] a) R. Streubel, S. Barcikowski, B. Gökce, Optics Letters 2016, 41, 1486. // b) S. Kohsakowski, F. Seiser, J.-P. Wiederrecht,
S. Reichenberger, T. Vinnay, S. Barcikowski, G. Marzun, Nanotechnology, 2019, recently accepted with title "Effective size separation of laser-generated, surfactant-free nanoparticles by continuous centrifugation"

[6] a) M. Lau, *S. Reichenberger*, I. Haxhiaj, S. Barcikowski, A. M. Müller, ACS Appl Energy Mater. 2018, 1, 5366–5385 // b) F. Waag, B. Gokce, C. Kalapu, G. Bendt, S. Salamon, J. Landers, U. Hagemann, M. Heidelmann, S. Schulz, H. Wende, N. Hartmann, M. Behrens, S. Barcikowski, Sci. Rep. 2017, 7, 13161

Session Classification: SUPER PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **39** Type: **not specified**

TSAMPIKOS KOTTOS: Time-Reversal Symmetry and its Applications: From Waveform Shaping to System Protection

Monday, 17 February 2020 11:30 (1 hour)

Time-reversal symmetry and its violation is one of the most powerful concepts in physics. It has applications in many physics subfields ranging from condensed matter, optics and atomic physics to mathematical physics and quantum field theories. In this talk, we will focus on two specific implementations of time-reversal symmetry (and its violation) in the field of electrodynamics with relevance to: (a) the design of waveforms of incident electromagnetic radiation that efficiently direct energy at focal points, with applications varying from non- invasive medical therapies and wireless elecommunications to electromagnetic warfare; and (b) the design of reflective photonic limiters used for protection of sensitive sensors from high- power/fluence incoming radiation.

We will highlight the connections between these two (at first glance diametrically different) applications while at the same time we will be placing the presented research effort within the framework of recently emerging sub-field of non-Hermitian wave transport.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **40** Type: **not specified**

EMERSON SADURNÍ: Extended quantum particles in free fall: Analytical treatment of their diffraction

Monday, 17 February 2020 12:30 (1 hour)

The diffraction of atomic and molecular beams is typically described by non-trivial solutions of the stationary Schroedinger equation. This has been done for structureless particles in the absence of external fields. In this contribution, the techniques that incorporate both internal composition and a gravitational field are presented. A derivation of the corresponding propagator is provided without approximations, identifying the center-of-mass propagation coordinate with a pseudo-time. In the paraxial regime –borrowed from optics– it is shown that a superposition of Moshinsky functions with internal molecular states gives rise to corrected diffraction patterns in the far, intermediate and near field regions along the optical axis. The limit of small molecular radii in diatomic harmonic models is discussed. Single and multiple slit diffraction patterns are studied, displaying corrections to the emergent Talbot carpets. Implications on quantum tests of the equivalence principle are briefly reviewed in this light, showing that modified probability densities arise when small deviations from unity of the inertial-to-gravitational mass ratio are considered.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **41** Type: **not specified**

JOHN FRANCO: Quantum gravimetry insensitive to external disturbances using composite light pulses

Monday, 17 February 2020 16:00 (30 minutes)

We introduce an atomic gravimetric sequence using Raman-type composite light pulses that excites a superposition of two momentum states with the same internal level. The scheme allows the suppression of common noise, making it less sensitive to external fluctuations of electromagnetic fields. The Raman beams are generated with a fiber modulator and are capable of momentum transfer in opposite directions. We obtain analytical expressions for the interference fringes in terms of three perturbative parameters that characterize the imperfections due to undesired frequencies introduced by the modulation process. We find special values of the Rabi frequency that improve the fringes visibility.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **42** Type: **not specified**

GUILLERMO VÁZQUEZ: Reactive transport in terms of Graphical and Chemical Operads

Monday, 17 February 2020 16:30 (30 minutes)

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **43** Type: **not specified**

THOMAS STEGMANN: Electron optics in phosphorene pn junctions

Monday, 17 February 2020 17:00 (30 minutes)

Ballistic electrons in phosphorene pn junctions show optical-like phenomena. Phosphorene is modeled by a tight-binding Hamiltonian that describes its electronic structure at low energies, where the electrons behave in the armchair direction as massive Dirac fermions and in the orthogonal zigzag direction as Schrödinger electrons. Applying the continuum approximation, we derive the electron optics laws in phosphorene pn junctions, which show very particular and unusual properties. Due to the anisotropy of the electronic structure, these laws depend strongly on the orientation of the junction with respect to the sublattice. Negative and anomalous reflection are observed for tilted junctions, while the typical specular reflection is found only, if the junction is parallel to the zigzag or armchair edges. Moreover, omni-directional total reflection, called anti-super-Klein tunneling, is observed if the junction is parallel to the armchair edge. Applying the nonequilibrium Green's function method on the tight-binding model, we calculate numerically the current flow. The good agreement of both approaches confirms the atypical transport properties, which can be used in nano-devices to collimate and filter the electron flow, or to switch its direction.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **44** Type: **not specified**

MIZTLI YÉPEZ: Wave transport through disordered waveguides: the effective response and the statistics of the scattering matrix

Monday, 17 February 2020 18:00 (30 minutes)

We present theoretical and numerical results for the statistical averages of the scattered waves in disordered waveguides. The theoretical results, based on a perturbative method, show that the averages scattering amplitudes of the disordered region depend only on a few characteristic lengths related to microscopic details of the disorder: the mean free paths. Theoretical average amplitudes show an excellent agreement with numerical simulations. This comparison exhibits that the average transmission amplitude is described successfully by an effective medium response; in contrast, only when the recurrent scattering contributions can be neglected, the average reflection amplitude is described satisfactorily by an effective medium. These results for the average scattering amplitudes suggest that the statistical distribution of the scattering matrix of disordered waveguides, does not satisfy the isotropic hypothesis assumed in the DMPK (Dorokhov, Mello, Pereyra and Kumar) description, where the phases of the scattering matrix are assumed equally probable. Our numerical simulations confirm that the isotropic hypothesis is not valid in general, it is suitable only for systems with lengths larger than the mean free path.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **45** Type: **not specified**

HUMBERTO LAGUNA: The Wigner function of Open Quantum Systems and position-momentum correlation

Monday, 17 February 2020 18:30 (30 minutes)

The interest in Open Quantum Systems (OQS) has increased as OQS has been applied for the study of diverse physical phenomena. In this work we study the Wigner functions of the Harmonic Oscillator (HO) and two coupled Harmonic Oscillators (the Moshinsky atom). Both models were coupled with a bath under two different coupling bath-system regimes: a) pure-dephasing without relaxation and b) relaxation without pure-dephasing. The time evolution of the phase-space functions was analyzed with the aid of information-theoretic tools (Shannon entropy and mutual information). The time evolution of the localization in phase space and of the position-momentum correlation is analyzed.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **46** Type: **not specified**

GABRIELA BÁEZ: Elastic Metamaterial Engineering

Monday, 17 February 2020 19:00 (30 minutes)

The design of artificial materials, with emerging anomalous properties, is a very active frontier research today due to the multiple and novel applications based on new physics. These new materials, also called metamaterials, are characterized by their wave phenomenology that defies our intuition: superfocusing, invisibility and slowing down, among others.

The main challenge of metamaterials is their mass production since, so far, only samples whose anomalous emergent properties have been verified in small frequency intervals have been manufactured. The first samples manufactured successfully, at the beginning of our 21st century, were electromagnetic metamaterials, characterized by their negative refractive index. On the other hand, elastic metamaterials present a greater degree of difficulty, due to the coupling between the different polarizations of the mechanical waves, as well as the conversion between them.

In this conference we present experimental evidence of the control of mechanical waves through some structured elastic metamaterials, strategically designed and manufactured in our research group. Some emergent properties of these elastic materials are Bloch oscillations; rainbow entrapment and near-zero group speed.

This frontier research has potential applications in seismology; in the design of modern cities and in the automotive, aeronautical and aerospace industries since comfort, maintenance and mainly the safety of vehicles depend on control of elastic waves and mechanical vibrations in them.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **47** Type: **not specified**

RAFAEL MÉNDEZ: Artificial Mechanical Molecules

Tuesday, 18 February 2020 11:30 (1 hour)

We show that it is possible emulate the pz orbitals of aromatic molecules using mechanical vibrations. This is done from the theoretical, numerical and experimental points of view. When connecting resonators through locally periodic structures, the resonances can be trapped thanks to the bandgaps of the locally periodic connectors [1,2]. This trapping yields a similar phenomenology to what happens with tightly bound electrons in quantum systems: the resonators take the role of the atoms, the connectors the role of the chemical bonds and the trapped vibrations the role of the orbitals. As a first system, a 1D chain of mechanical atoms is studied. In this case the spectrum and wave amplitudes agree with those obtained by
a quantum tight-binding model, in which the frequency takes the role of the energy. With the same ideas the pz orbitals of some aromatic molecules are emulated.

This work was supported by DGAPA-UNAM under project IN109318 and by CONACYT under project 284096.

[1] F. Ramírez-Ramírez, R. A. Méndez-Sánchez, G. Báez, A. Morales, L. Gutierrez, and J. Flores, Emulating Tunneling with Elastic Vibrating Beams, 2018 Progress in Electromagnetic Research Symposium (PIERS-Toyama), 10-23919/PIERS.2018.8597751.

[2] F. Ramírez-Ramírez, E. Flores-Olmedo, G. Báez, E. Sadurní, and R. A. Méndez-Sánchez. Emulating tightly bound electrons in crystalline solids using mechanical waves. ArXiv: 1922.11272.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **48** Type: **not specified**

ALBERTO ROBLEDO: Localization, a nonlinear dynamical equivalent and its presence in complex systems

Tuesday, 18 February 2020 12:30 (1 hour)

We describe a particular excursion into the study of the localization phenomenon, kept within a family of simple model systems for the scattering of a propagating wave. The models are fully solvable and suitable for revealing an analogous nonlinear dynamical problem. A recursion relation for the system-size dependence of the scattering matrix relates to a bifurcation diagram where single point and weakly chaotic attractors represent insulating and conducting regimes, and the in-between transition to chaos characterizes the mobility edge. While the simplicity of the models allows for the consideration of other localization phenomena, like those for light and sound, its mathematical description can be couched in the language of Mobius transformations in the complex plane, and this in turn can be directed to abstract number theoretical questions and properties. Finally, we sketch extensions of these studies towards the modeling of coherent collective patterns and motion in complex systems composed of living entities.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **49** Type: **not specified**

BARBARA DIETZ: Quantum Chaotic Scattering Experiments with Microwave Billiards, Random Matrix Theory and their Application to Nuclear Data

Wednesday, 19 February 2020 11:30 (1 hour)

I will speak about experiments with flat microwave resonators with and without induced time-reversal invariance violation. The scattering matrix formalism for such systems is equivalent to that developed for the random matrix theory description of compound nuclear reactions. Accordingly, the extraordinary advantage of such experiments is that they render possible the experimental verification of a variety of statistical measures for the fluctuation properties in the spectra of the associated scattering matrix and thus the development of tools for the characterization of nuclear spectra. Recently, we validated analytical expressions for the distribution of the off-diagonal cross sections based on these microwave data and then
applied them to excitation functions of the compound-nuclear reaction 37 Cl(p,a) 34 S.
Furthermore, we studied the fluctuation properties in the energy spectra of 208 Pb. High resolution experiments have recently lead to a complete identification of the energy values,
spin, and parity of 151 nuclear levels. We analyzed their fluctuation properties using random matrix theory and also the method of Bayesian inference. The talk basically reviews the
results published in [1-5].

This work was supported by the Deutsche Forschungsgemeinschaft (DFG) within the Collaborative Research Center 643 and 1245. BD thanks the NSF of China for financial support under Grant Nos. 11775100 and 11961131009.

[1] S. Kumar, B. Dietz, T. Guhr, and A. Richter, Distribution of Off-Diagonal Cross Sections in Quantum Chaotic Scattering: Exact Results and Data Comparison, Phys. Rev. Lett. 119, 244102 (2017).
[2] B. Dietz, A. Heusler, K. H. Maier, A. Richter, and B. A. Brown, Chaos and Regularity in the Doubly Magic Nucleus 208 Pb, Phys. Rev. Lett. 118, 012501 (2017).
[3] S. Kumar, A. Nock, H.-J. Sommers, T. Guhr, B. Dietz, M. Miski-Oglu, A. Richter, F. Schäfer, Distribution of scattering matrix elements in quantum chaotic scattering, Phys. Rev. Lett. 111, 030403 (2013).
[4] Dietz, T. Friedrich, H. L. Harney, M. Miski-Oglu, A. Richter, F. Schäfer, H. A. Weidenmüller, Quantum chaotic scattering in microwave resonators, Phys. Rev. E 81, 036205 (2010).
[5] B. Dietz, T. Friedrich, H. L. Harney, M. Miski-Oglu, A. Richter, F. Schäfer, J. Verbaarschot, H. A. Weidenmüller, Induced Violation of Time-Reversal Invariance in the Regime of Weakly Overlapping Resonances, Phys. Rev. Lett. 103, 064101 (2009).

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **50** Type: **not specified**

THOMAS GORIN: Quantum predecessors of stochastic processes with an application to the Ising spin chain

Wednesday, 19 February 2020 12:30 (1 hour)

One may think of classical stochastic processes as arising from the evolution of an open quantum system in the limit of strong decoherence. From this perspective, one would start with a quantum system, assume a coupling to the environment and eventually reach the classical stochastic process in the limit of strong decoherence. Here, we to proceed in the opposite direction: Given a discrete-time classical Markov process, we derive a description in terms of a sequence of quantum channels. We then modify these quantum channels in such a way that random "which path"-decisions are replaced by the superposition of all possible paths. This procedure is restricted by the requirement that the original classical stochastic process would be recovered, if sufficiently frequent and complete measurements were performed. As a consequence, the resulting process is typically semi-quantum, i.e. intermediate between purely quantum (i.e. unitary) and purely stochastic (i.e. classical).

We apply this procedure to the stochastic dynamics of an Ising spin chain under a high-to-zero temperature quench. We find that the resulting semi-quantum process conserves a surprisingly large amount of coherence. As compared to the classical process, we find a number of notable differences in the behavior of macroscopic variables, such as a faster equilibration time.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **51** Type: **not specified**

ALEJANDRO GARCÍA: On the canonical transformations group and polymer quantum mechanics

Wednesday, 19 February 2020 16:00 (30 minutes)

Polymer quantum mechanics constitutes a theoretical lab where some of the mathematical techniques used in Loop Quantum Cosmology and Loop Quantum Gravity can be tested or better understood. On the other hand, the canonical transformations are an essential tool of the Hamiltonian formalism at both, classical and quantum level. In this talk, I will discuss the unitary representation of the canonical transformation within the polymer quantum mechanics scheme and will show some of its implications.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **52** Type: **not specified**

ANTONIO FERNÁNDEZ: Aerogel-based metasurfaces for perfect acoustic energy absorption

Wednesday, 19 February 2020 16:30 (30 minutes)

Silica aerogels are nanoporous lightweight materials the frame of which consists of an assembly of connected small cross-sections beam-like elements resulting from fused nanoparticles. This particular assembly additionally provides silica aerogel a very low elastic stiffness when compared to rigid silica structure of identical porosity. Therefore, when aerogel plates are clamped, they are excellent candidates to design acoustic metamaterials, because they exhibit subwavelength resonances and present efficient absorption capabilities. In this work we will study theoretically, numerically and experimentally a perfect absorbing metamaterial panel made of periodically arranged resonant building blocks consisting of a slit loaded by a clamped aerogel plate backed by a closed cavity. The impedance matching condition is analyzed using the Argand diagram of the reflection coefficient. The lack or excess of losses in the system can be identified via this Argand diagram in order to achieve the impedance matching condition. The results obtained show a good agreement between the analytical results and those measured experimentally.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **53** Type: **not specified**

ROBIN SAGAR: Information Entropies, Correlations, and Applications in Continuous Variable Quantum Systems

Wednesday, 19 February 2020 17:00 (30 minutes)

A review of the tools taken from information theory and how they have been used to analyze quantum systems will be presented. Formulations of uncertainty relations in entropic terms will be discussed with emphasis on the behaviors in the position, momentum and phase-space representations. Statistical correlations between (among) particles will also be addressed

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **54** Type: **not specified**

ADRIÁN ORTEGA: Spectral and transport properties of a simple PT -symmetric tight-binding chain with gain and loss

Wednesday, 19 February 2020 18:00 (30 minutes)

We consider a simple PT-symmetric tight-binding chain with gain and loss in a symmetric configuration. Using the explicit expressions for the eigenvalues and eigenvectors of the model, we obtain the values of the parameters at which exceptional points occur, and determine the behavior of the eigenvalues and eigenfunctions around these exceptional points perturbatively. These results are used to analyze transport through the chain. We find that for the eigenstates corresponding to complex eigenvalues in the broken PT -symmetric phase, transport is deficient, and the ratio of inflow and outflow is different from one, leading to an exponential increase or decrease of the density in the chain.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **55** Type: **not specified**

VICTOR IBARRA-SIERRA: Method for finding effective Hamiltonian of time-driven quantum systems

Wednesday, 19 February 2020 18:30 (30 minutes)

Time-driven quantum systems are essential in many different fields of physics as cold atoms, solid-state, optics, etc. Many of their properties are encoded in the time evolution operator or the effective Hamiltonian. Finding these operators usually requires very complicated calculations that often involve some approximations. In this talk, we present a theoretical model that exploits the structure of the associated Lie group for time-periodic Hamiltonians. This method allows us to find the time evolution operator through the decomposition on each group generator and, subsequently, the effective Hamiltonian.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **56** Type: **not specified**

LUCA TESSIERI: Transport and localization phenomena in media with correlated disorder

Thursday, 20 February 2020 11:30 (1 hour)

We present a review of some important results obtained in the field of propagation and localization of waves in one-dimensional models with correlated disorder. In particular, we discuss how specific correlations of the random potential can give rise to peculiar transport properties in random media. We analyze some of the techniques used to deal with correlated disorder, including the Hamiltonian map approach and the recent "ers"approximation. Finally, we discuss how the results valid for 1D models are being extended to 2D and 3D systems.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **57** Type: **not specified**

CECILIA NOGUEZ: Flatland: Two-dimensional heterostructures with van der Waals interactions

Thursday, 20 February 2020 12:30 (1 hour)

Two-dimensional (2D) van der Waals (vdW) heterostructures are a new realm of materials with potential applications and fascinating physical properties. Besides graphene (G), transition metal dichalcogenides (TMDCs) have been considered as promising building blocks in 2D vdW heterostructures with improved and new properties. The vertical stacking of at least two atomic monolayers bonded by vdW forces with different electronic behavior, i.e. G/TMDC, leads to new hybrid nanostructures. In principle, hybrids could retain the main advantages of pristine monolayers at the same time that they might achieve superior and unusual properties which cannot be obtained otherwise. In recent years, the combination of G and TMDCs, such as tungsten disulfide (WS2) and molybdenum disulfide (MoS2) have attracted increasing interest as promising building blocks for future electronics, photonics and optoelectronic devices. First, we present a general unfolding method for the electronic bands of systems with double-periodicity. Within density functional theory with atomic orbitals as basis-set, our method takes into account two symmetry operations of the primitive cell: a standard expansion and a single rotation, letting to elucidate the physical effects associated to the mutual interactions between systems with more than one periodicity. As a result, our unfolding method allows studying the electronic properties of vertically stacked homo- or heterostructures. Then, we apply our method to study G/WS2 heterostructures with different interlayer angles. Our unfolding method allows observing typical mini gaps reported in heterostructures, as well as other electronic deviations from pristine structures, impossible to distinguish without an unfolding method. We anticipate that this unfolding method can be useful to compare with experiments to elucidate the electronic properties of two-dimensional homo- or heterostructures, where the interlayer angle can be considered as an additional parameter.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **58** Type: **not specified**

ÁNGEL MARTÍNEZ: Transport studies in three-terminal microwave graphs with orthogonal, unitary, and symplectic symmetry

Thursday, 20 February 2020 16:00 (30 minutes)

The Landauer-Büttiker formalism establishes an equivalence between the electrical conduction through a device, e.g., a quantum dot, and the transmission. Guided by this analogy we perform transmission measurements through three-port microwave graphs with orthogonal, unitary, and symplectic symmetry, thus mimicking three-terminal voltage drop devices. One of the ports is placed as input and a second one as output, while a third port isused as a probe. Analytical predictions show good agreement with the measurements in the presence of orthogonal and unitary symmetries, provided that the absorption and the influence of the coupling port are taken into account.The symplectic symmetry is realized in specifically designed graphs mimicking spin-1/2 systems. Again a good agreement between experiment and theory is found. For the symplectic case the results are marginally sensitive to absorption and coupling strength of the port, in contrast to the orthogonal and unitary case.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **59** Type: **not specified**

RUTH DIAMANT: Photonic Crystals in the Amplitude and Phase Representation

Thursday, 20 February 2020 16:30 (30 minutes)

We use a classical optics approach to obtain the Bloch functions for several one-dimensional photonic crystals. To accomplish this, we choose the amplitude and phase representation, which leads us to a new procedure. These Bloch functions are based on numerical solutions to the field's amplitude equation, letting the refractive index vary continuously and periodically along one direction. Band gaps are found in the process too. Some interesting differences between electron and electromagnetic wave behavior are pointed out.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **60** Type: **not specified**

EDUARDO BARRIOS: Laser-induced boundary states in graphite

Thursday, 20 February 2020 17:00 (30 minutes)

The common classification of the electronic phases (insulator, semiconductor, semimetal, and metal) of the matter is based on spectral properties. However, the discovery of the topological insulators (TI) added a new kind of classification based on topological information carried by the eigenstates of the system. A topological insulator is a material that behaves as an insulator in the bulk and hosts conducting surface states, these surface states are like highways for electrons. The conducting surface states are weakly affected by the disorder which is an attractive characteristic for applications. One way to induce topological electronic phases in common materials is by using laser illumination [1-4]. The illuminated material may host a topological state, a phase commonly known as Floquet topological insulator [4]. In this work, we explore laser-induced effects in graphite, where we find topological boundary states, these states propagate mainly along the borders. The topological states present a 'skeleton' in the reciprocal space.

[1] Oka, T.; Aoki, H. Phys. Rev. B 79, 081406 (2009).
[2] Lindner, N.H.; et al. Nat. Phys. 7, 490-495 (2011).
[3] P. M. Perez-Piskunow et al. Phys. Rev. B 89, 121401(R) (2014).
[4] H. L. Calvo et al. Phys. Rev. B 91, 241404 (2015).
[5] Hernan L. Calvo, Jose E. Barrios Vargas, Luis E. F. Foa Torres, arXiv:1911.02144.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **61** Type: **not specified**

CARLOS PINEDA: A quantum framework for coarse graining and fuzzy measurements

Thursday, 20 February 2020 18:00 (30 minutes)

We present a quantum framework for coarse graining and fuzzy measurements in a multiparticle system, based solely on what might be physically measured. For example the case of coarse graining, we assume that the detectors can measure only randomly selected particles with a physically motivated distribution. For the case of fuzzy measurements, we assume that the detectors might be placed incorrectly, leading to misidentification of some particles. In the space of states, both situations induce completely positive maps that lead to a shrinking of the state space. These maps are studied in detail; physical quantities such as the measurable entanglement (and thus the ability to perform tasks such as teleportation), and purity are considered. In addition, by considering the symmetries and spectra of the maps, we calculate the shrinking rate of the space of states. Finally, we consider the many particle limit and find that only an exponentially small subset of the state space is observable if one has imperfect detectors. In the limit of infinite particles, this set coincides with the many particle coherent states, and thus we call this subset the classical space.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **62** Type: **not specified**

SHI-HAI DONG: Entanglement measures for W-class states in noninertial frame

Thursday, 20 February 2020 18:30 (30 minutes)

We present the entanglement measures of a tetrapartite W-Class entangled system in noninertial frame, where the transformation between Minkowski and Rindler coordinates is applied. Two cases are considered. First, when one qubit has uniform acceleration whilst the other three remain stationary. Second, when two qubits have nonuniform accelerations and the others stay inertial. The 1-1 tangle, 1-3 tangle and whole entanglement measurements $\pi 4$ and $\Pi 4$, are studied and illustrated with graphics through their dependency on the acceleration parameter rd for the first case and rc and rd for the second case. It is found that the negativities (1-1 tangle and 1-3 tangle) and π -tangle decrease when the acceleration parameter rd or in the second case rc and rd increase, remaining a nonzero entanglement in the majority of the results. This means that the system will be always entangled except for special cases. It is shown that only the 1-1 tangle for the first case, vanishes at infinite accelerations, but for the second case the 1-1 tangle disappears completely when r>0.472473. It is found an analytical expression for von Neumann information entropy of the system and we notice that it increases with the acceleration parameter.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **63** Type: **not specified**

LUCA CELARDO: Cooperative effects and long range interactions: from Superradiance to Cooperative Shielding

Friday, 21 February 2020 16:00 (30 minutes)

Cooperative effects are at the center of interest in many systems in physics such as cold atomic clouds, light harvesting systems, and trapped ions. Cooperative effects such as Superradiance and Supertransfer induce enhanced energy transport efficiency and robustness to noise. In the first part of the talk we will review the role of Superradiance/Superabsorption in light-harvesting systems. Design of efficient devices for photon sensing and light-harvesting based on Superabsoption will be discussed. At the heart of Superradiance lies the long range of the interactions mediated by the photon field between the molecules.

The second part of the talk will be devoted to discuss the interplay of cooperativity and noise in systems with long range interaction which can be implemented in ion trapped experiments. The main focus will be on Cooperative Shielding. Contrary to the common expectation that long-range interaction should necessarily induce an instantaneous spread of information in the thermodynamic limit, we show that, as the system size increases, the dynamics can actually become more confined into invariant subspaces. In such subspaces, the dynamics is effectively shielded from long-range interaction, that is, it occurs as if that interaction was absent. Shielding is a cooperative effect, because the time over which it is effective diverges with system size.

[1] Superradiance Transition in Photosynthetic Light-Harvesting Complexes, G.L.Celardo , F. Borgonovi, V.I. Tsifrinovich, M. Merkli and G.P. Berman, The Journal of Physical Chemistry C, 116, 22105 (2012).
[2] Shielding and localization in the presence of long-range hopping, G. L. Celardo, R. Kaiser and F. Borgonovi, Phys. Rev. B 94, 144206 (2016).
[3] Cooperative Shielding in Many-Body Systems with Long-Range Interaction, L. Santos, F. Borgonovi and G.L.Celardo, Phys. Rev. Lett. 116, 250402 (2016).

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **64** Type: **not specified**

HORACIO PILÓN: An analytic representation for the three-body interaction

Friday, 21 February 2020 16:30 (30 minutes)

An analytic representation of the three-body potential for the ground state of the molecular ion H_3^{++} in equilateral triangle configuration is presented. This representation is based on an adequate description of the two-body potential energy curve $V(R)$ for the diatomic molecule H_2^+. The accurate representation of $V(R)$ for H_2^+ is achieved by matching short and long distances behavior via two-point Pad´e approximation. In general, the approximation provides 3-4 significant digits correctly.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **65** Type: **not specified**

MAURICIO LÓPEZ: Measuring with Fundamental Constants

Friday, 21 February 2020 17:00 (30 minutes)

The phrase "one measure for all men and all times"summarizes the ideal that would lead to the development of the International System of Units, SI. The evolution of the definitions of the SI units of measurement may be somehow considered as a series of approximations to such an ideal in which the units of measurement are invariant in time and space, immutable, and susceptible to equivalent realizations, reproducible, and accessible to be useful in measuring processes of practical, industrial, technological and scientific purposes. In the current state of the science and technology the fundamental constants appear as the last frontier to define the SI units of measurement. The abandonment of artifacts to support the definitions of SI units began in 1960 when the wavelength of a krypton 86 radiation was used to redefine the unit of length, the meter. Moreover, the time unit, defined in 1967 in terms of the separation of the ground state hyperfine levels of the Cesium-133 atom, was another important step towards the incorporation of the fundamental constants in the SI units. In 1982, the unit of length was established in terms of the speed of light in vacuum and time measurements. This clearly illustrates how the SI evolves towards the incorporation of fundamental constants, or combinations of them, to support the units of measurement. In May 20th, 2019, the SI unit for mass, the kilogram, was redefined in terms of the Planck constant. Setting a value without uncertainty for Planck's constant and by defining the kilogram in terms of electromagnetic forces generated in a balance, usually called "watt balance", the definition of the kilogram is framed in the context of the quantum mechanics, since it rely experimentally on the time unit, and therefore on the hyperfine separation of the ground state of Cesium-133 atom, on the realizations of the volt in terms of the Josephson effect and on the ohm in terms of the quantum Hall effect. Also, the SI units for the electric current and temperature, the Ampere and the Kelvin, were redefined last May 20th in terms of the electric charge of the electron and the Boltzmann constant, respectively. The new definitions of the SI base units will allow the fundamental constants to be the support of the SI, that in order to provide measurement systems with a very high accuracy to pursuit the scientific and technological advances to come.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **66** Type: **not specified**

ANDREAS BUCHLETINER: Quantum transport in complex systems: from single to many particles

Wednesday, 19 February 2020 10:00 (1 hour)

While a longstanding subject in different areas of physics, quantum transport in "complex"systems has recently moved back into focus, not least due to remarkable progresses in the experimental characterization and control of multi-component quantum systems. Whereas quantum optics had long followed a strictly reductionist program, with the aim to isolate and control single constituents of matter, we now can witness how "complex"phenomena rapidly emerge as moderate numbers of these constituents are brought together again, at an unprecedented level of control. On a practical level, e.g., entangled states of light are identified as potential information carriers for quantum communication across turbulent media, and multiply connected ensembles of qubits are configured into "prototype quantum computers"which permit nice experimental demonstrations of the actual challenge to control their long-time evolution. This phenomenology raises beautiful theoretical questions with an interest in their own right, such as to which extent "complex"dynamical or transport phenomena can be controlled - at least on a statistical level -, whether robust control can be achieved by exploiting generic and robust features of complex quantum systems, or how targeted performance can be reliably certified, notwithstanding the impossibility of deterministic control or validation as the arguably defining property of truly "complex" quantum systems. Starting out from some by now "historical"examples of "complex" single-particle, the talk will subsequently expand on some current topics in the area of many-particle quantum transport, with an emphasis on the competition between many-particle (in-) distinguishability, interactions, and entanglement, on the one hand, and symmetries and disorder, on the other one.

Session Classification: SUPER PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **67** Type: **not specified**

HORACIO PASTAWSKI: Decoherent Quantum Transport: from Giant Magnetoresistance and SASERs to Quantum Dynamical Phase Transitions

Friday, 21 February 2020 10:00 (1 hour)

Quantum conductance in molecular and nano systems at low temperatures becomes well understood through the Landauer's motto: "conductance is a transmittance"as calculated from the Schrödinger Equation (SE). However, quantum dynamics is inevitably affected by decoherence which, in turn, becomes critical to recover the macroscopic Ohm's law. In spite of this, the few works that include these effects still resort to the early developments that describe the steady-state in terms of the D'Amato-Pastawski (DP) model [1,2]. Its basic idea is that because of the electron-phonon and other interactions with an "environment", an electron loss its memory of its initial state following a Poisson process with a mean-life described by a Fermi Golden Rule (FGR). After each interaction it initiates a "new life". Here, I will show that non-Hermitian Hamiltonians and the Keldysh Green's functions are the natural setting to describe these processes [3]. I describe how Keldysh integral equations become highly simplified for the DP model in a linear response regime consistent with Landauer approach. The observables are evaluated self-consistently in a discrete space and can be readily generalized to time dependent situations in a multi-terminal settings.[4].

As illustrations for these equations I discuss 1-D model for the Giant Magnetoresistance (GMR). Starting from a quantum description, we recover the standard two resistor model of the GMR. This is achieved by increasing the decoherence controlled by the mean free path and the spin-flip rate, which are Hamiltonian parameters, and determine the observed transport properties. In a device length scale lower than the mean free path, there are interferences that depend on the domain wall size identified with Rabi oscillations. I also discuss a Resonant Tunneling Device where the e-ph scattering processes are considered, within a Fock space description beyond the FGR approximation. This leads to a simple model, which becomes a Floquet Hamiltonian for a classical vibrational field, with antiresonances and resonances in the Fock-Floquet space that describe a phonon laser (SASER) [5]. The inclusion of further decoherence processes, besides smoothing out of the resonances, leads to the degradation of the contrast mainly from the suppression of the antiresonances.

In a second part, I will show that non-Hermitian Hamiltonians not only imply a trivial exponential decay of quantum memory but could also induce a Quantum Dynamical Phase Transitions as that observed in a SWAP gate [6]. These can be interpreted in terms of spectral bifurcations (exceptional points) in the solutions of the Schrödinger equation, i.e. the complex eigen-energies of the non-Hermitian Hamiltonian. However, quite the dynamical phase transition only shows up in the density described by Keldysh or Lindblad equations, as exceptional points in frequency spectrum, not associated with the energies [7]. I also will explore this situation with a stochastic SE algorithm [8], the quantum drift (QD), which is a dynamical implementation of the DP model that captures QDPT. As QD involves a single pure wave function that represents the whole thermal ensemble, it is very effective to push the computational limits for decoherent many-body dynamics. Furthermore, by implementing a forward quantum dynamics followed by another one backwards in time and evaluating the Loschmidt Echo, showing that decoherence does not occur uniformly in time but that it is more effective while the state goes through a superposition (entangled) state. This is consistent with our recent experimental findings [9] that the entangled states are more sensitive to the action of local environments than the simple pointer states. Thus, the extreme sensitivity of the SE of a many-body system to even infinitesimal perturbations, ensures the emergence of the Second Law of Thermodynamics.

[1] J. L. D'Amato and H. M. Pastawski, Conductance of a Disordered Linear Chain including inelastic Scattering events. Phys. Rev. B 41, 7411 (1990).

[2] S. Datta, A simple kinetic equation for steady-state quantum transport J. Phys.: Condens. Matter 2, 8023 (1990).
[3] H. M. Pastawski Classical and Quantum Transport from Generalized Landauer-Büttiker Equations II: Time dependent tunneling. Phys. Rev. B 46 4053-4070 (1992).
[4] C. J. Cattena, L. Fernández-Alcázar, D. Nozaki, R. A. Bustos-Marún, and H. M. Pastawski, Generalized multi-terminal decoherent transport: recursive algorithms and applications to SASER and giant magnetoresistance J. Phys. Condens. Matter 26, 345304 (2014).
[5] L. E. F. Foa Torres, H. M. Pastawski, and S. S. Makler, Tuning a resonance in the Fock space: Optimization of phonon emission in a resonant tunneling device Phys. Rev. B. 64, 193304 (2001); W. Maryam, A.V. Akimov, R.P. Campion A.J. Kent, Dynamics of a vertical cavity quantum cascade phonon laser structure, Nat. Commun. 4, 2184 (2013).
[6] G.A. Álvarez, E.P. Danieli, P.R. Levstein, and H.M. Pastawski, Environmentally induced quantum dynamical phase transition in the spin swapping operation J.Chem.Phys. 124, 1 (2006).
[7] H.M. Pastawski, Revisiting the Fermi Golden Rule: Quantum dynamical phase transition as a paradigm shift, Physica B 398 278 (2007).
[8] L. J. Fernández-Alcázar and H.M. Pastawski, Decoherent time-dependent transport beyond the Landauer-Büttiker formulation: A quantum-drift alternative to quantum jumps, Phys. Rev. A 91, 022117 (2015).
[9] C. M. Sánchez, A. K. Chattah, K. X. Wei, L. Buljubasich, P. Cappellaro and H. M. Pastawski, Emergent perturbation independent decay of the Loschmidt Echo in a many-body system. arXiv 1902.06628.

Session Classification: SUPER PLENARY TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **68** Type: **not specified**

JOSÉ LUIS LÓPEZ: Presence of Avoided Crossings in Rectangular Thin Plates.

Thursday, 20 February 2020 19:00 (30 minutes)

In this talk it is introduced the basics of Classical Plate Theory and Random Matrix Theory in order to appreciate the discovery and consequences of avoided crossings in a free vibrating rectangular elastic billiard. Mathematical, Numerical and Experimental evidences are presented.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON SCATTERING, QUANTUM AND CLASSICAL TRANSPORT

Contribution ID: **69** Type: **not specified**

EMMANUEL HARO:Nanostructured surfaces and bulk systems synthesized by laser ablation: fabrication and subsequent experiments.

Monday, 17 February 2020 11:30 (45 minutes)

In this presentation we review some experimental and theoretical results obtained in our group related to laser ablation and laser patterning. The need of developing original solutions for obtaining nanostructured materials is raised. Furthermore we report on a new method that combines the Laser Ablation and the Sol-Gel techniques in order to obtain nanostructured glasses. Au nanoparticles are generated by pulsed laser deposition using the corresponding target. The target is immersed in a transparent solution previously prepared made of tetraethyl orthosilicate, and water. The ablation process was performed subsequently using a NdYAG laser emitting at 532 nm. The pulse duration was 8 ns at a frequency of 10 HZ. Once the nanoparticles were dispersed in the solution the gels were stored for 24 hours at room temperature. After that the samples were thermally treated at 300℃ for 10 hours in order to obtain the glasses. High resolution transmission electron microscopy images and UV-visible spectroscopy were used to characterize the Au nanoparticles.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **70** Type: **not specified**

AKSHANA PARAMESWARAN: Nanostructured thin films of tin sulphide for photodetector applications from pulsed laser ablated nanocolloids

Monday, 17 February 2020 12:15 (30 minutes)

Photodetectors based on nanostructured semiconductor materials have been successfully used in advanced communications, flame detection, air purification, ozone sensing and leak detection, among others, in the past few decades. We present fabrication and characterization of photodetectors based on nanomaterials using their nanocolloids prepared by Liquid-phase Pulsed Laser Ablation technique which can lead to photodetection in enhanced wavelength ranges with improved efficiency. Tin sulfide (SnS) nanoparticles were synthesized by pulsed laser ablation of a SnS target in different liquid media using the 1064 nm output wavelengths from a pulsed (10 ns, 10 Hz) Nd:YAG laser. The nanocolloids obtained were spin coated on different substrates for the development of thin films and also the p-type SnS nanocolloids were deposited on an n-Si wafer for the p–n heterojunction fabrication. The fabricated films were characterized by techniques like UV-Visible spectroscopy, XPS, Raman, SEM, XRD etc. To investigate the photoresponse, the device was illuminated using varying light emitting diodes (LED) and bias voltages. The key parameters of a photodetector, the responsivity (R), sensitivity, detectivity, rise time and fall time were estimated.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **71** Type: **not specified**

TUPAK GARCÍA: Photoacoustic analysis during laser synthesis and processing of colloids

Monday, 17 February 2020 12:45 (30 minutes)

Nanoparticles (NPs) of Au and Ag were obtained by laser synthesis and processing of colloids, including laser ablation, fragmentation and melting in liquids. Some parameters as the laser pulse energy (from few mJ to100 mJ) and repetition rate of the laser pulses (RRLP, in the range from 1–10 Hz), as well as the lens to target distance (LTD) were varied, which produced changes in the concentrations and dimensions of synthesized NPs. The synthesis process and resulting Ag-NPs colloids were studied by a pulsed photoacoustic technique. Characteristic parameters of PA signals such as bubble collapse time, arrival time and root mean square were determined as functions of the number of laser pulses, RRLP and LTD. For comparison, other techniques as UV-Vis-IR analysis, atomic absorption spectroscopy, electron microscopy, as well as the measurement of the transmission of the laser pulses through the colloid were used. The results show that the photoacoustic analysis can be used in-situ and in real-time for obtaining useful information on both the synthesis process and the colloids themselves.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **72** Type: **not specified**

LUIS MENDOZA: Ultrafast study of cyanine IR-780: efficiency of two photon absorption by control of molecule release.

Monday, 17 February 2020 13:15 (15 minutes)

Materials that have properties of two-photon absorption (2PA), such as cyanine dyes, have wide applications in emerging areas such as coherent laser control, optical limiting, photofarmacology or 3-dimensional imaging of biological tissue [1,2]. In this study, the efficiency of 2PA of cyanines was explored by the two-photon induced fluorescence (TPIF) technique with a femtosecond laser [3]. An Optical Parametric Amplifier (OPA) has been used to excite a sample at various wavelengths in regular intervals in the near-infrared (850-1050 nm); light-induced fluorescence has been produced by the sample and said light in the proper intensity regime has been chosen so as to trigger the 2PA phenomenon. Rhodamine B and 6G were used as standard and validation, respectively; relevant cross-sections were also measured. This work is ongoing, and we will discuss the experimental setup as well as the results obtained so far. These preliminaries results are complementary to other studies of femtochemistry for this type of molecules [4]. We are determining the best properties (efficiency of 2PA) with the aim of using these dyes as antennas that can release species with the advantages of enhanced spatial selectivity and deeper light penetration.

References

[1] A. Konar, D. Shah, V. Lozovoy, and M. Dantus. J. Phys. Chem. Lett. 2012, 3, 1329–1335

[2] F. Friedrich, et al., Chem. Commun., 51, 15382 (2015).

[3] Oulianov, D. A., Optics communications, 191, 235-243 (2001).

[4] Guarin, C. A., J. P. Villabona, López, R., Peon, J. J. Phys. Chem. B 2013, 117(24): 7352-7362.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **73** Type: **not specified**

CITLALI SÁNCHEZ: Nanosecond laser nanostructuring of glass assisted by thin films, nanoparticles and nanoprism arrays

Monday, 17 February 2020 16:00 (45 minutes)

Nanostructures have an outstanding potential in several industrial applications, which has motivated to develop fast, easy and flexible methods for their fabrication. Laser irradiation of metal nanostructures such as thin films and nanoparticles induces melting and ablation, which allows the transformation of the nanostructures itself, and the structuration of the substrate below them. For instance, ns pulsed-laser irradiation converts metal films previously deposited on non-wetting substrates, into metal nanodroplets. Once the droplets have been produced, subsequent irradiation allows either the tailoring of the nanoparticles'shape or the nano-drilling of the substrate at the position of the droplets. We study the effect of laser parameters (laser fluence, wavelength and pulse number) and the background pressure on the formation of these nanostructures. In addition, the irradiation of periodic arrays deposited by nanosphere lithography was performed, allowing the morphological manipulation of the nanospheres and the ordered structuration of the substrate.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **74** Type: **not specified**

VICTOR CONTRERAS: Analysis of liquids impurities with LIBS assisted by acoustic levitation sampling.

Monday, 17 February 2020 16:45 (30 minutes)

Real-time and multi-elemental analysis for online water monitoring is an important task towards environmental safety, public health, water purification control, the adequate reuse of wastewater, and for many processes in engineering and industrial fields. However, the online water monitoring cannot be performed by analytical conventional techniques (LA-ICP-MS, ICP-OES or XRF) because they demand long operation times and/or specialized handling. Laser induced breakdown spectroscopy (LIBS) represents one of the most appealing alternatives for multi-elemental analysis where rapid information is required. For liquids analyses, it has been demonstrated that LIBS improve its analytical performance when drops are trapped and partially dried by an acoustic levitation system, enabling multi-elemental trace detection on liquids with relatively simple instrumentation requirements.
In this talk I will introduce the methodology based on LIBS assisted by acoustic levitation sampling. The talk will focus on the generation of acoustic potentials for single-axis acoustic levitation systems and the most interesting spectroscopic results based in the analysis of trace heavy metal detection contained in liquid samples acoustically levitated. The approach is addressed to develop a methodology for online monitoring applications demanding limited volumes of liquid samples with simple instrumentation.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **75** Type: **not specified**

SHARMA KANAKKILLAM: Pulsed laser fragmentation of nanostructured ZnO-Co2O3 materials for solar photocatalysis.

Monday, 17 February 2020 17:15 (15 minutes)

Photocatalysis is an emerging field in which the solar energy/visible light is utilized for different types of catalytic applications including elimination of contaminants from water, air, soil, water splitting mechanisms, sterilization etc. Metal oxide nanoparticles and its different categories like modified metal oxides, nanocomposites, hybrids etc. were used commonly for photocatalytic applications. Here we modified zinc oxide nano powders with cobalt oxide by a simple unique synthesis technique called pulsed laser fragmentation in liquid. The modification was conducted by pulsed laser fragmentation of cobalt oxide powder in water to make a stable nanocolloid. Then zinc oxide powder was mixed to it and laser irradiation was carried out. All these processes finished within 45 minutes so that green powders were obtained. The synthesized powders were taken for characterization techniques like UV-Visible spectroscopy, XPS, Raman, SEM etc. Their photocatalytic properties were studied using degradation of dyes under visible light irradiation. Details of the characterization, properties and photocatalysis are included in this work.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **76** Type: **not specified**

BEATRIZ DE LA MORA: Strategies for functionalization of gold nanoparticles fabricated by laser ablation in liquids.

Monday, 17 February 2020 18:00 (30 minutes)

In the last 20 years the field of nanotechnology has grown extensively due to its surface, optical and magnetic properties. Among the different types of nanoparticles gold nanoparticles (Au-NPs) outstand due its optical properties, chemical surface and biocompatibility. Laser ablation in liquids (LAL) is a synthesis method that allow to obtain high purity gold nanoparticles in a variety of solvents for different applications. In general, for the different applications gold nanoparticles require a functionalization. To functionalize gold nanoparticles obtain from ALL need different strategies than the ones used for colloidal solutions produced by chemical synthesis. The presence of the plasm during the formation of Au-NPs, the wide distribution sizes and the flocculation state of the colloidal solution changes the surface chemistry of the Au NPs. Here, a study of the physicochemical properties of Au-NPs obtained by ALL and functionalized with different thiolate compounds (AMP, Dodecanethiol and POSS thiol) is presented. Floculation, size distribution, stability and optical response were measured by TEM microscopy, ⍰ potential, DLS and UV-Vis spectroscopy. Some strategies to get a successful functionalization such as a post-treatment of the colloidal solution with laser treatment and centrifugation to diminish the size distribution of the particles, the optimization of concentration of the thiol compounds and the use of buffers to modify the pH of the solutions are discussed.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **77** Type: **not specified**

JOSÉ MORALES: Commercial aluminum foil as a substrate for Surface-Enhanced Raman Spectroscopy: A study via atomic force microscopy (AFM) and scanning electron microscopy (SEM).

Monday, 17 February 2020 18:30 (15 minutes)

Three commercial brands of aluminum foil available in Mexico (Reinolds, Avilés, Great Value) are studied. In this work, we have obtained experimental results, which demonstrate that commercial aluminum foil enhances the Raman signal. The Raman signal enhancement of methylene blue at a concentration of 1x10-6 M has been analyzed by placing a drop (6 ul) onto samples of the three commercial brands of aluminum foil and the reference. Preliminary results show that Raman enhancement has been observed in the Great Value samples. Microchannels on the surface of the three commercial brands of aluminum foil have been observed via SEM and AFM; their origin is possibly due to the aluminum foil manufacturing process. We hypothesize that these microchannels give rise to the Raman enhancement of methylene blue.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **78** Type: **not specified**

V. GÁMEZ-ALBO: Synthesis of silver nanoparticles in a liquid medium for application as bactericidal and fungicidal agents.

Monday, 17 February 2020 18:45 (15 minutes)

In this work, a fast and efficient method for the synthesis of silver nanoparticles coated with silica by means of the laser ablation technique in combination with oxidation-reduction mechanisms in aqueous solution is presented. This method is a chemical synthesis where the reducer agent is introduced in nanometer form by laser ablation of a solid target submerged in an aqueous solution. In a first step a silicon target immersed in water was ablated for several minutes. After this, the material extracted and suspended in the solution was re-irradiated using a lower energy density to finish fractionating the larger particles. Subsequently, an aliquot of an AgNO3 dissolution was added and the redox reaction produced between the silver ions and ablation products leads to a colloidal suspension of core-shell Ag@Silica NPs. For the stability of the colloids, Na2CO3 was also added to the solution. Once synthesized, silica-coated silver nanoparticles can be used as bactericidal agents when irradiated with a low energy density in the absorption region, which causes resonance of surface plasmons, resulting in several scenarios that can cause death of nearby bacteria. However, for fungicidal applications where the specimens are larger, an AlCl3 solution was used to promote the tendency of the nanoparticles towards agglomerations, which allows such application. On the other hand, the colloidal suspensions were studied by UV-VIS-NIR spectroscopy, dynamic light scattering (DLS) and electrophoretic light scattering (ELS). Also, pH measurements were carried out.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **79** Type: **not specified**

LINDA GARCÍA: Femtosecond laser-induced crystallization in Antimony Sulphide thin films (Sb2S3).

Monday, 17 February 2020 19:00 (30 minutes)

In recent years, the use of thin films of metal chalcogenides has been increased in photovoltaic solar technology. Mainly, semiconductor materials such as Antimony Sulphide (Sb2S3) are used due to their high absorption coefficient and band gap (1.7-2.5 eV). However, Sb2S3 thin films obtained by chemical bath, the most common method of manufacturing them, have an absence of crystallinity, making it necessary to use post-deposit or in situ treatments to improve their crystalline properties, important for the performance of the photovoltaic device. The main objective of this work is to promote, by laser irradiation with ultrashort pulses, the crystallization of thin films of Sb2S3 obtained by a chemical bath. The laser irradiation will be carried out by using femtosecond laser pulses (1030 nm, 250 fs, 2 MHz), varying the irradiation parameters such as fluence, repetition rate, and scanning speed. Also, the characterization of Sb2S3 films is contemplated, before and after laser irradiation. Therefore, it will be determined changes in the structure (X-Ray Diffraction); the thickness of the films (Reflection and Transmission Spectroscopy); the molecular structure (Raman Spectroscopy); its elementary composition (XPS); morphology of the films and their roughness (AFM); optical properties (UV-Vis-NIR Spectroscopy); and, electrical and photoconductivity measurements of the films.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **80** Type: **not specified**

CARLOS ACOSTA: Modelling of single nanosecond laser pulse-induced modifications of Silicon surfaces.

Monday, 17 February 2020 19:30 (15 minutes)

Irradiation with a single nanosecond laser pulse in the melting regime can result in a characteristic change in the surface morphology of crystalline silicon. This has been verified experimentally in a variety of situations. In certain irradiation conditions dimple-shaped surface topographies are produced. In this work the dimple height, depth and width are modelled following the approach of Schwarz-Selinger and coworkers, upon varying the laser irradiation parameters like peak energy density, pulse duration and wavelength. This is achieved with numerical simulations of one-dimensional heat flow as input to the analytical fluid-flow equations. This model has been implemented in order to explain some results obtained in nanosecond laser-induced interference grating formation experiments on silicon.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **81** Type: **not specified**

SADASIVAN SHAJI: Pulsed laser ablation in liquid – Nanocolloids to thin films and devices.

Tuesday, 18 February 2020 11:30 (45 minutes)

Pulsed laser ablation in liquid (PLAL) is an interesting green technique to synthesize nanoparticles of metals, semiconductors, polymers and ceramics. We have synthesized nanoparticles of metals, semiconductors and ceramics using PLAL. Also explored the effects ablation wavelength, fluence and post irradiation effects on the morphology and properties of nanomaterials fabricated. From these nanocolloids, we have prepared and characterized thin films and coatings using different techniques. Also, these thin films were used to fabricate devices like photodetector and solar cells. Details of the characterization and properties nanomaterials by PLAL as well as their thin film device properties are included in this work.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **82** Type: **not specified**

CÉSAR GUARÍN: Disentangling the different and ultrafast relaxation processes in aromatic molecules.

Tuesday, 18 February 2020 12:15 (30 minutes)

The energy that carries an electromagnetic wave can be transferred to a chemical species via absorption. Once the molecule is in an excited state, it relaxes through various photophysical and photochemical channels [1]. Molecular dynamics is important because it involves the various deactivation channels through which the excitation energy dissipates. This study investigates the dynamics of relaxation of molecules of more than 25 atoms in condensed phase (polar and nonpolar solvents). We are working on the implementation of ultrafast spectroscopy techniques (pump-probe) and we also employ a computational approach (DFT and TDDFT) to study the ultrafast decay in aromatic molecules [2].
In this study, we show that the solvent-effect leads to a change in the relative energies of the singlet and triplet excited states. The presence of n-type orbitals in substituted aromatic molecules implies the existence of upper excited states, which substantially increase the coupling between the singlet and triplet manifolds. It should be noted that, along with the spectroscopic techniques that will allow us to accurately measure these processes, the current advances in computational methods allow us to clarify the details of the relaxation dynamics, including the geometries, the relative energies of the excited states, the conformational changes or intermediate species, all of which affect the efficiency of the decay processes [3]. Clarifying the relaxation dynamics of electronic states involved in ultrafast decay is vital for the development of the next generation of photo-materials.

References
[1] Klessinger, M.; Michl, J. Excited States and Photochemistry of Organic Molecules, VCH: New York, 1995
[2] López-Arteaga, R., Guarin, C. A., Jorge Peon, J. J. Phys. Chem. B. 2013, 117, 9947-9955
[3] Anders B. Skov. et al., Phys. Chem. Chem. Phys., 2018, 20, 13412

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **83** Type: **not specified**

SANTIAGO CAMACHO: Short and ultrashort pulsed laser processing of materials at CICESE.

Tuesday, 18 February 2020 12:45 (45 minutes)

CICESE was the first institution in México to build and operate (three decades ago) an ultrashort pulse laser system in México. In year 2003 we created the laboratory of ultrashort pulse lasers and processing of materials. Since then we have consolidated a research group that focuses on the following topics: fs laser-induced metallic oxides; fs laser-writing of photonics structures in transparent materials with special interest on polycrystalline ceramics; laser-induced periodic surface structures (LIPSS); synthesis of core-shell nanoparticles by laser ablation of solids in liquids; and laser-induced cavitation focused on medical applications. Some relevant results are the rapid formation of multiple phase nanostructured metallic oxides; laser-induced index shaping through oxygen vacancy suppression; transition from plasmonic to dielectric LIPSS; luminescent Bi@C nanoparticles; and the measurement of intraocular pressure through laser-induced cavitation. In this presentation, we will elaborate on the research group activities, our current infrastructure and potential collaborations we are open to.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **84** Type: **not specified**

SVEN REICHENBERGER: Pulsed laser post-processing of colloidal metal and oxidic nanoparticles to tailor nanomaterials properties.

Wednesday, 19 February 2020 11:30 (45 minutes)

In the field of catalysis research and catalyst development especially tailored catalyst design is only possible when structure-activity correlations are mechanistically understood [1]. To that end, catalyst materials with gradually tuned properties are required. A promising tool to deliver nanomaterials with increasingly altered properties (e.g. band gap or photo-luminescence) and consequently catalytic activities is given by Pulsed Laser Post Processing (PLPP) in liquids [2-5]. Functionalization of catalysts with surfactant-free laser generated co-catalysts (e.g. Au NP) prior to PLPP5 enables further systematic studies of potential active sites present on the heterogenous catalyst during reaction. While a gradual tuning of materials properties is mainly achieved by controlling the number of laser pulses per particle (I. e. mass-specific energy dose, see Fig. 1), the transformation processes driven by each individual laser pulse will (considering constant laser pulse duration and wavelength) directly depend on the applied laser fluence being the main driving force. Consequently, fluence gradients known to occur in state of the art PLPP setups need to be avoided [4].

Within this presentation, a new flat-jet setup, minimizing the fluence gradient will be presented and subsequently evaluated regarding the homogeneity of the PLPP process at the example of well-established laser fragmentation of gold nanoparticles. Next, recent advances on laser-based processing of oxidic nanomaterials using nano- and picosecond lasers and its implication for the catalytic activity in different types of catalytic reactions will be presented and discussed.

Acknowledgments:
The authors gratefully acknowledge the Mercator Research Centre Ruhr (MERKCUR) for funding the project Pr-2016-0044 and the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) –Projektnummer 388390466 –TRR 247

References

1. A. J. Medford, A. Vojvodic, J. S. Hummelshøj, J. Voss, F. Abild-Pedersen, F. Studt, T. Bligaard, A. Nilsson, and J. K. Nørskov, Journal of Catalysis, vol. 328, pp. 36–42, (2015).
2. S. Reichenberger, G. Marzun, M. Muhler, S. Barcikowski, ChemCatChem. 2019, 11 (18), 4489
3. M. Lau, S. Barcikowski, Appl. Surf. Sci., 348, 22–29 (2015)
4. F. Waag, B. Goekce, C. Kalapu, G. Bendt, S. Salamon, J. Landers, U. Hagemann, M. Heidelmann, S. Schulz, H. Wende, N Hartmann,
M. Behrens, S. Barcikowski, Scientific Reports, 7, 1-13, (2017)
5. M. Lau, S. Reichenberger, I. Haxhiaj, S. Barcikowski, A. M. Müller, ACS Applied Energy Materials 1, 5366–5385, (2018)

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **85** Type: **not specified**

RAMÓN CARRILES: Nano- and micro-machining of stainless steel for superhydrophobicity.

Wednesday, 19 February 2020 12:15 (30 minutes)

We will present a brief overview of CIO´s experimental work on ablation and micro-machining using an ultrafast amplified system (50 fs, 1 kHz). Specifically, we will cover surface nano- and micro-machining of stainless steel to achieve superhydrophobicity; also, we will present results on nanoparticle ablation from solid targets immersed in liquid.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **86** Type: **not specified**

LUIS ESCOBAR: Laser ablation of metals submerged in water as an alternative method for hydrogen production.

Wednesday, 19 February 2020 12:45 (45 minutes)

The laser ablation of solids in liquid medium has been actively used in the last two decades for the synthesis and processing of nanoparticles. An important effect of the plasma formation as a result of the laser-solid interaction is that some of the plasma surrounding liquid is vaporized producing a cavitation bubble. This bubble expands to its maximum size and then collapses, this process occurs at temperatures of thousands of Kelvin and pressures of several GPa. Under these extreme conditions if the liquid is water, splitting in hydrogen and oxygen occur, so that it can be considered as an alternative way to produce hydrogen. The generation of hydrogen upon ablation of different metals: Al, Mg, Ti and four different Al-Mg alloys with different Al content is reported. A ns pulsed Nd: YAG laser emitting in the fundamental line (1064 nm) was used to ablate each metal immersed in 20 mL of deionized water for 5 minutes, with and without the presence of an ultrasonic field. The laser beam was directed perpendicular to the surface of the metal target contained inside of a sealed glass flask. The flask was connected through a flexible hose to a glass beaker with water, in which an inverted graduated cylinder was placed; the volume of the produced gas (hydrogen) was determined directly by measuring the displacement of the liquid. Experiments varying the laser fluence at higher values from 27 to 77 J/cm2, as well as at lower fluences from 0.7 to 1.8 J/cm2 were performed. The produced gas was characterized by gas chromatography and mass spectrometry. Molecular hydrogen was found suggesting that this procedure allows the production of H2 of high purity. In general terms, all the studied metals under laser ablation produce H2 and the volume rise as the laser fluence was increased following a no-linear monotonic behavior with similar tendencies. The present approach to generate hydrogen can be considered as a bifunctional procedure because at the same time it can be used to produce nanomaterials with different shape and size as by-products.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **87** Type: **not specified**

ARTURO ROBLEDO: Effect of the sample's temperature on the line emission in laser ablation at cryogenic temperatures.

Wednesday, 19 February 2020 16:00 (45 minutes)

We report results obtained in a laser-ablation experiment using targets chilled down to 20 K. In a previous work, our co-workers found that by increasing the temperature of the target above room temperature the emission of the lines increased in proportion to the target's temperature [1]. In the present work we applied the focused beam of a pulsed, nanosecond Nd:YAG laser on a metallic surface that is in contact with the cold finger of a He refrigerator. In this way the sample' s temperature could be varied in the interval 20-290 K. The sample and the cold finger were kept in a high vacuum in order to obtain good thermal insulation. In the present work we noticed a slight increment in the emissivity of the lines as the temperature increased. The most notable effect however, one that was unexpected, is that at low temperatures (˜20K) the electron density of the plasma was found to be higher than at room temperature. The explanation for this behavior is attributed to a pre-heating of the target before plasma onset. This is a consequence of the sharp variation of the sample's specific heat with temperature, according to Debye's theory.

References

[1] E. Alvarez-Zauco et al, Applied Physics B 108 (2012) 867–873.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **88** Type: **not specified**

OSMARY DEPABLOS-RIVERA: Analysis of plasmas produced by pulsed laser ablation combined with magnetron sputtering.

Wednesday, 19 February 2020 16:45 (30 minutes)

The plasma diagnostic is an in-situ method to monitor the deposition processes that involve the generation of plasmas. The pulsed laser ablation (PLA) and magnetron sputtering (MS) are plasma-assisted deposition techniques. Their combination is known as hybrid technique and denoted as MS-PLA. This hybrid technique has been employed to prepare coatings and films with specific applications such as solid lubrication, photocatalysis and biomedical materials. We implemented the hybrid technique MS-PLA to prepare films of ZnO-Au, an Au target was ablated and MS was used to deposit ZnO. The aim of this work was to diagnose the plasmas generated during the hybrid deposition by optical emission spectroscopy (OES). Additionally, the plasmas produced during the PLA of an Au target in high vacuum and under an Ar atmosphere (0.67 Pa) were studied. These PLA plasmas were studied as reference to understand the effects of the plasmas combination in the hybrid process MS-PLA. The processes with PLA were done varying the pulse laser fluence at 4.5, 13.6 and 20.9 J cm-2. The OES results allowed to identify and to analyze the emission evolution of neutral atoms of Au, Ar and Zn and single-ionized Au atoms. The loss of material from the growing films was evidenced during the PLA of Au under Ar atmosphere because the emission of Au neutral atoms increased in front of the substrates. However, the increase of Au emission near the substrates did not occur during the hybrid deposition, while the increase of the Zn emission was observed. The Zn excitation revealed the energy loss of the Au species by the collisions, and their final energy caused less removal of material from the films with respect to the PLA process in Ar. Consequently, the deposition rate improved in the hybrid process.

Acknowledgment: This work was supported by DGAPA-UNAM-IG100418-PAPIIT, CONACyT-INFR 280635 and FONCICYT-CONACyT-CNR-278094 projects. O. Depablos-Rivera and M. Martínez-Fuentes are grateful to CONACyT No. 1740 project and DGAPA-CIC-UNAM for their postdoctoral fellowships, respectively.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **89** Type: **not specified**

ÁLVARO LÓPEZ: Separation and size determination of silver nanoparticles synthesized by laser ablation in liquid.

Wednesday, 19 February 2020 17:15 (15 minutes)

The unique properties of silver particles are strongly dependent on the size and shape of the nanoparticles, NPs [1]. Ablation synthesis in solution has some limitations in the size control of NPs. So, to have a uniform size distribution at the time of synthesizing the NPs in solution, either by chemical method [2] or by laser ablation [3], has been a problem that is difficult to solve. Among traditional separation methods, centrifugal separation technology has been successfully applied in the separation and purification of different types of NPs [4]. In this report, a simple method is shown to obtain size distribution-controlled spherical silver nanoparticles, Ag-NPs, by repeated centrifugation-dispersion steps, controlling the centrifugation speed. The morphology and surface plasmon resonance for Ag-NPs, were investigated by scanning-transmission electron microscopy, STEM, and UV-Vis absorption spectroscopy, respectively. Meanwhile, the statistics of the size distribution of the separated nanoparticles was taken from the microscopy images using software for particle measurement and data analysis. During this study, the results obtained for each centrifugation stage, their corresponding values for the central peak of the surface plasmon resonance and the percentage of the majority population of NPs report nanoparticles in the range of 11 to 20 nm of diameter. In conclusion, a viable procedure was found for the separation of spherical Ag-NPs by size and therefore a way to standardize nanoparticles size distribution.

REFERENCES:
[1] Shape effects in plasmon resonance of individual colloidal silver nanoparticles, J. J. Mock, M. Barbic, D. R. Smith, D. A. Schultz and S. Schultz, J. Chem. Phys. 116, 2002, 6755.
[2] Silver nanoparticles synthesized by direct photoreduction of metal salts. Application in surface-enhanced Raman spectroscopy, R. Sato-Berrú,R. Redón, A. Vázquez-Olmos, J. M. Saniger, J.Raman Spectrosc. 40, 2009, 376.
[3] Nanomaterials via Laser Ablation/Irradiation in Liquid: A Review, H. Zeng, X. W. Du, S. C. Singh, S. A. Kulinich , S. Yang, J. He, W. Cai, Adv. Funct. Mater. 22, 2012, 1333.
[4] Methods for separation, identification, characterization and quantification of silver nanoparticles, J-F. Liu, S-J. Yu, Y-G. Yin, J-B. Chao, Trends in Analytical Chemistry 33, 2012, 95.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **90** Type: **not specified**

MARCO CAMACHO LÓPEZ: Laser-induced transformations in metal oxides and metals.

Wednesday, 19 February 2020 18:00 (45 minutes)

In the last few years our group have been focusing on three main research areas. The first one concerns the study of cw-laser induced transformations in metal oxides and metals as molybdenum oxide and bismuth thin films. The second one is the study of pulsed ns-laser induced effects on some metallic materials as titanium, molybdenum and bismuth thin films, the third one and more recent is the preparation of nanoparticles colloids by using the laser ablation of solids in liquids technique. As an example of our current research activities, in this talk I will present experimental results on the modification of bismuth thin films under nanosecond laser irradiation. Varying the per pulse laser fluence and the irradiation time, i. e. the number of pulses, bismuth can be significantly modified. We have found either the formation of Laser Induced Periodic Surface Structures (LIPSS) or oxidation effects depending on number of delivered laser pulses for a well determined per pulse laser fluence. This laser processing technique let us obtain, in a very simple form, micrometric sized regions with either LIPSS or metallic oxides patterning. Potential applications for this processed surfaces are for instance gas sensor and SERS substrates, among others.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **91** Type: **not specified**

ÁULIDE MARTÍNEZ: Bessel beam propagation in calcium vapor and conical emission.

Wednesday, 19 February 2020 18:45 (15 minutes)

We have observed anomalous conical emission from the first resonant transition of calcium (λca=422.67nm) using two types of laser beam, Gaussian and zeroth-order Bessel beams. We used the third harmonic of a Nd:YAG laser to pump a homemade tunable dye laser to excite the transition, and a 1° axicon to produce the Bessel beams. The conical emission featured different half-angles for the same wavelength as a function of the excitation beam. The results of our experiments support conical emission models based upon four-wave mixing, and we believe this is due to the fact we have modified the phase-matching condition with the zeroth-order Bessel beam wave vector.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **92** Type: **not specified**

GERARDO CONTRERAS: Thin film and device processing at the Pulse Laser Deposition (PLD) laboratories of the Superior School of Physics and Mathematics (ESFM) –IPN and the Chemistry Faculty (FQ)-UAQ.

Thursday, 20 February 2020 11:30 (45 minutes)

In this talk we present the research studies at Escuela Superior de Física y Matemáticas-IPN and Facultad de Química-UAQ with the use of the Pulse Laser Deposition (PLD) technique. The research work is oriented to the following topics, namely: a) The thin film processing and characterization by PLD and applications as white light emitters of HfO2; b) Thin film processing and characterization of GaN and ternary compounds by PLD and their possible use as LED´s; c) The processing and characterization by PLD of Transparent Conducting Oxides of SrCuSeF and its employ in solar cells; d) The processing and photovoltaic-performance characterization of CdS/CdTe solar cells by the PLD technique.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **93** Type: **not specified**

ENRIQUE ESPARZA: Monolayers of cholesterol deposited by Langmuir-Blodgett technique on nanostructured substrates.

Thursday, 20 February 2020 12:15 (15 minutes)

Cholesterol monolayers were deposited by the Langmuir-Blodgett (LB) technique on silicon wafers, glass slides, nano structured silicon wafers and nanostructured glass slides. These latter substrates are known as nanostructured substrates (SN) since they have deposited a silver film by the pulsed laser ablation technique (ALP). The films were characterized by the Raman spectroscopy technique to study whether the SERS effect (Surface Enhanced Raman Spectroscopy) presented by nanostructured substrates aids in the detection of thin films synthesized by the LB technique.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **94** Type: **not specified**

ROSALBA CASTAÑEDA: Synthesis of lead free electroceramics thin films by PLD.

Thursday, 20 February 2020 12:30 (30 minutes)

Lead-free piezoelectric materials were developed during the second half of the past century, among them, the potassium sodium niobate (K0.5Na0.5)NbO3 (KNN), KNN-based ferroelectrics and based ferroelectrics in Titanates of Barium (BaTiO3), are considered a promising lead-free materials alternative to Pb(Zr,Ti)O3 (PZT,) particularly the KNN by its high Curie temperature (Tc). Using PLD (pulsed laser deposition) we grown thin films of (K0.5Na0.5)NbO3 (KNN) and Ba1-xCaxTi0.9Zr0.1O3 (BCTZ). KNN thin films were deposited on Pt/TiO2/SiO2/Si substrates at different deposition conditions (substrates temperature, oxygen pressure and laser fluence). BCTZ were deposited on Si and glass substrates at different conditions. The morphology of all the films were examined by scanning electronic microscope (SEM). The structural analysis of the films was performed by Pulsed Laser Photoacoustic (PLPA) technique, this method was employed to identify the structural phases and structural changes with the increase in temperature. Furthermore, X-ray Diffraction Spectroscopy (XRD), X-ray Photoelectron Spectroscopy (XPS) and Raman Spectroscopy were performed to prove the PLPA results. The PLPA analysis shows tetragonal structural phase in KNN thin films, and the orthorhombic and tetragonal structural phases in the BCTZ thin films.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **95** Type: **not specified**

PAULINA SEGOVIA-OLVERA: Laser induced periodic surface structures on Bi and Ti thin films under femtosecond irradiation.

Thursday, 20 February 2020 13:00 (30 minutes)

The laser induce periodic surface structures (LIPSS) have attracted considerable attention due to its potential to change, improve or provide new features to material surfaces. LIPSS appear as a quasi periodic pattern of parallel lines on the surface after being irradiated with linearly polarized laser radiation. These structures can be generated in a single-step process and their characteristics are strongly correlated with the irradiation parameters, such as; wavelength, polarization, angle of incidence. Generally, LIPSS are classified in two groups depending on their periodicity referred as Low Spatial Frequency LIPSS (LSFL) and High Spatial Frequency LIPSS (HSFL). Particularly, the use of femtosecond laser pulses to generate LIPSS offers the advantage of minimizing the formation of the heat-affected zone (HAZ), improving the spatial resolution of the surface modification. In this context, the LIPSS formation with fs pulses offers a plethora of options to design and fabricate functional surfaces with complex morphologies in micro and nano scale. Nevertheless, considering that the formation of the structures also depends on material properties and surrounding media, controlling the morphology of the LIPSS is a very difficult task. In this sense, the most recent results in the study of the formation of LIPSS on metals obtained by our research group will be discussed in this presentation.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **96** Type: **not specified**

JOSÉ LUIS HERNÁNDEZ: Enhanced light transmission in disordered metallic nanoisland flims.

Thursday, 20 February 2020 16:00 (45 minutes)

In this talk we will present a brief historical review about metallic films with arrays of ordered holes which present extraordinary optical transmission. Then, the transmission properties of thin gold, copper and silver films deposited on quartz by pulsed laser deposition are presented. Well before the deposited metal forms a continuous film, these metals form islands on the substrate, when these islands reach a critical distance, the light transmission near the surface plasmon resonance frequency is enhanced. These results remind of extraordinary optical transmission, however, instead of having relatively sharp peaks of transmission at characteristic frequencies, in our experiments broad peaks at are observed.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **97** Type: **not specified**

NOÉ ENRÍQUEZ: Synthesis of manganese oxides by laser ablation of solids in liquids (LASL).

Thursday, 20 February 2020 16:45 (15 minutes)

Currently there are a number of different methods for obtaining nanosized materials such as thermal oxidation, sol-gel method, solvothermal synthesis, among others. However, the laser ablation of solids in liquids (LASL) technique has acquired great importance due to its relatively low cost, also considered as a green technique because it does not generates by-products and extra chemicals are not required for the synthesis. In addition, a large variety of nanomaterials can be obtained with a simple variation of the laser irradiation parameters during the synthesis, which translates into the modification of sizes and morphologies of the created nanostructures. It is a fast technique since it allows to obtain nanomaterials in a short time as compared to the long synthesis times required by some chemical techniques.
In this work, colloidal suspensions of manganese oxide nanoparticles were synthesized, especially the Mn3O4 phase, by using LASL. The experiments were carried out by ablating a manganese target immersed in deionized water as the liquid medium. In addition, the effect of ablation time on the formation of these oxides was studied, this being an important parameter for the final composition of the obtained products. The optical properties were characterized, as well as the structure and morphology of the obtained nanoparticles.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **98** Type: **not specified**

NOÉ ZAMORA: Synthesis of Molybdenum Oxide Nanoparticles by Laser Ablation of Solids in Liquids.

Thursday, 20 February 2020 17:00 (30 minutes)

The synthesis of molybdenum oxide (MoOx) nanoparticles (NPs) by using the laser ablation of solids in liquids (LASL) technique and their oxidation process was investigated. S/TEM-EDX microscopy images were used to study the oxidation process of these type of NPs. We hypothesized that the NPs oxidation depends on size, particularly it was observed that the smaller the NP not only the more oxidizes but the faster. The formation of spherical core-shell type NPs was seen in most cases. Besides, micro-Raman spectroscopy shows the shell is composed of molybdenum trioxides hydrated (MoO3 ·xH2O), x= 1/3, ½ and 1.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **99** Type: **not specified**

MIGUEL ÁNGEL CAMACHO: Short pulsed laser synthesis of nanomaterials and optical characterization of materials at UAEMex.

Thursday, 20 February 2020 18:00 (45 minutes)

In year 2004 we created the "Laboratorio de Fotomedicina, Biofotónica y Espectroscopía Láser de Pulsos Ultracortos". Since then we have consolidated the Laser Ablation of Solids in Liquids (LASL) technique through a 30 ps Nd:YAG laser system, UV-Vis spectroscopy and photoluminescence (PL) spectroscopy. Our research group focuses on the following topics: synthesis of colloidal nanoparticles by laser ablation of solids in liquids; optical characterization of materials and nanomaterials by using UV-Vis and PL, laser-induced photothermal effects in metallic nanoparticles, optical characterization of radiochromic films and the characterization of the optically stimulated luminescence of some crystals. In this presentation, we will elaborate on the research group activities, our current infrastructure and potential collaborations we are open to.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **100** Type: **not specified**

KATIA DEL CARMEN: Synthesis and optoelectronic properties of nanocomposites of Sb2S3 with Si from laser ablated nanocolloids.

Thursday, 20 February 2020 18:45 (15 minutes)

Pulsed laser ablation in liquid technique is used frequently due to the advantage of obtention of stable, surfactant free nanomaterials in colloidal form. In this work, we synthesized semiconductor nanocolloids with laser ablation in liquid. The ablation process was carried out with pure Sb2S3 target and with additions of polycrystalline-Si and monocrystalline-Si in ethyl alcohol solution and thin films were deposited by spin coating. Different morphology has been observed in synthesis by means of laser ablation and deposition by spin coating compared to the conventional one obtained by other synthesis technique like chemical bath deposition. Characterization on their structure, morphology, elemental composition, chemical states, optical and electrical properties are done. Results on these hybrid nanostructured thin films at optimized synthesis parameters and their optoelectronic properties will be presented.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **101** Type: **not specified**

FERNANDO GONZÁLEZ-ZAVALA: Pulsed laser deposition of silver vanadates thin films employing two non-conventional array plasmas.

Thursday, 20 February 2020 19:00 (15 minutes)

Thin films of vanadium oxide compounded with silver were prepared by pulsed laser deposition using a two parallel plasmas and sequential plasmas configuration on glass and silicon substrates (100). These substrates were placed in front of the expansion line of the plasmas at a distance of 6 cm. For the array of parallel plasmas a high purity vanadium and silver targets were placed geometrically parallel and ablated simultaneously. During experiments the plasma parameters, mean ion kinetic energy and plasma density, of vanadium remain approximately constant while the plasma parameters of silver were varied in order to obtain different silver content in the deposited thin film.
For the sequential plasmas configuration different number of silver pellets were attached to the vanadium target in order to incorporate in the thin film different content of silver by varying the Ag/V ablated area ratio, for this experiments the plasma parameters, mean ion kinetic energy and plasma density, of vanadium and silver remain approximately constant.
All of these experiments were executed in vacuum chamber at working pressures close to 4x10-6 mbar and a Nd:YAG (1064nm) laser, pulse width 10 ns and a frequency of 10 Hz was employed. Afterwards, the thin films were subjected to thermal treatment at 450℃ in order to obtain crystalline oxides. The obtained materials were characterized by Raman spectroscopy showing that the thin films were composed by mixtures of vanadium oxides, silver vanadates, and silver oxides in different proportions. XPS confirmed the existence of mixtures of V2O5, V2O3, VO2 and AgVO3, as well as the presence of AgO and AgO2 for films prepared at higher silver plasma densities.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **102** Type: **not specified**

PATRICIA MALDONADO-ALTAMIRANO: Optical and morphological characterization of CdSe nanoparticles processed by laser ablation in liquid.

Thursday, 20 February 2020 19:15 (15 minutes)

In this work we present some results and analysis concerning the processing of semiconducting CdSe nanoparticles obtained by laser ablation of diluted CdSe powder in acetone. A Nd-YAG pulsed laser was used for ablation, tuned at the first and second harmonic, λ=1064 and 532 nm, 50 Hz frequency repetition during 30 minutes. The experiment was performed at different power intensities. An important difference in the size of the samples synthesized at 1064 nm and 532 nm is observed, being 12 nm for the samples processed with the infrared line and less than 5 nm for those processed with the green line. The emission and absorption of the samples runs from 1.8 to almost 2.4eV for the smallest particles. A deep analysis of the results is presented and discussed.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **103** Type: **not specified**

JOSÉ QUIÑONES: Control of plasma parameters for the pulsed laser deposition of alloys, compounds and composite thin films.

Friday, 21 February 2020 11:30 (45 minutes)

Pulsed laser deposition of thin films has proven to be a highly versatile technique for the growth of a number of different materials for almost any application. However, for the deposition of alloys, compounds or composite films, there are some drawbacks regarding targets preparation due to the deposited film is composed of two of more elements, making necessary the fabrication of targets with specific compositions depending of the material of interest.
On the other hand, the properties of the growing films are strongly dependent on both laser parameters and target physical properties, which makes the control of the deposition process and thus, the films properties in general, a difficult task. Plasma diagnostics in pulsed laser deposition experiments, has demonstrated to be a powerful tool for controlling experimental reproducibility and more important, to modify the deposited films properties. In this talk the influence of mean kinetic ion energy and density as measured by Langmuir planar probes on the deposition of alloys, compounds and composite thin films, will be discussed.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **104** Type: **not specified**

ANAHÍ LIMAS: Preparation of Graphite nanoparticles by laser ablation in distilled water with and without ultrasonic excitation.

Friday, 21 February 2020 12:15 (15 minutes)

In this work we report the synthesis of Graphite nanoparticles by laser ablation of a Graphite target immersed in distilled water. The laser used is a Nd: YAG emitting at 1064 nm with a pulsed length of 10 ns. The effect of an ultrasonic excitation and the laser energy density on the size and shape of the nanoparticles is investigated. The nanoparticles size and shape are determined from transmission electron microscopy (TEM) micrographs. The samples were characterized also by Raman spectroscopy. Photoluminescence measurements were also performed. The UV-Vis measurements show a typical plasmonic absorption at 265 nm approximately this band is characteristic of Graphite. In general samples fabricated under ultrasonic excitation are composed on nanoparticles and plane like structures. Without the presence of the ultrasonic field individual nanostructures having spherical shapes are observe. Furthermore different experimental conditions were studied such as height of water above the target and the spot size effect. The main results are presented

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **105** Type: **not specified**

LUIS FELIPE DEVIA: Ultrafast laser welding of ceramics.

Friday, 21 February 2020 12:30 (30 minutes)

Material welding techniques have been a key aspect in the last industrial era. In fact, still there are some welding challenging applications that involve ceramic characteristics i. e. joining pieces of components in which biocompatibility or extremely high temperatures are in play. High temperature resistance of ceramics makes its welding a complex and difficult process.
The present work describes an ultrafast pulsed laser welding approach that relies on focusing light on the interfaces to ensure an appropriate optical interaction volume in the ceramic pieces to stimulate nonlinear absorption processes, causing localized melting rather than ablation.
The methodology of this work considered the optical properties of the polycrystalline ceramics: linear and nonlinear absorption, and the laser parameters: exposure time, number of laser pulses, and pulse duration (femtosecond versus picosecond). The interplay between linear and nonlinear optical properties and laser energy–material coupling was studied. The resulting laser welding enable the ceramic pieces as integral components within devices for harsh environments as well as in optoelectronic and/or electronic packages needing visible-radio frequency transparency.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **106** Type: **not specified**

RENÉ RODRÍGUEZ: Femtosecond laser fabrication of periodic nanostructures on polymeric surfaces reinforced by carbon additives.

Friday, 21 February 2020 13:00 (30 minutes)

It has been demonstrated that carbon-based compounds, namely Expanded Graphite (EG), have become excellent fillers to reinforce polymers as Poly (ethylene terephthalate) (PET) to improve their mechanical resistance or electrical conductivity. Additionally, nanostructuring of polymers allows the modification of surface properties. A study about the generation of Laser Induced Periodic Surface Structures (LIPSS) in polymeric surfaces of PET and PET reinforced with expanded graphite is presented. Laser irradiation was carried out with the fundamental and the 3rd harmonic of a linearly polarized Ti:Sapphire laser (FWHM 120 fs for 795 nm and 260 fs for 265 nm; 1kHz) focused on thin films (˜100 nm thick) of the aforementioned materials deposited in glass, silicon, and metal substrates and on self-standing films (˜400 μm thick). Differences are observed for the films deposited on the different substrates in terms of irradiation parameters, i.e., fluence and number of pulses, needed for the onset of the formation of well-ordered nanostructures. Furthermore, the properties of the surfaces after irradiation were monitored. Atomic Force Microscopy (AFM) was used to analyze the topography and the adhesion force in the micrometer range. Contact angle measurements were carried out to evaluate the wettability of the samples and calculate the surface free energies. Finally, Raman spectroscopy was used to check possible chemical modifications in the materials. This study opens the possibility of extending the applicability of LIPSS to different combinations of deposited layers and substrates with properties on demand.

Session Classification: PLENARY TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **107** Type: **not specified**

ALEJANDRO CRUZ: Ag:Au bimetallic nanoparticles by pulsed laser ablation in liquid and their coatings.

Friday, 21 February 2020 16:00 (15 minutes)

Bimetallic nanoparticles have interesting properties for optical, electronic, magnetic and chemical applications. Pulsed laser ablation in liquid is an effective synthesis method to develop nanoparticles of metals, semiconductors and ceramics. In this work, colloidal solutions of bimetallic nanoparticles of silver / gold (50/50) were obtained by ablation using a Nd:YAG laser of 532 nm wavelength, with 10 nanosecond pulse, frequency 10 Hz. Then electrophoretic deposition was used to fabricate their coatings from bimetallic nanocolloids. The coating is deposited on different substrates under various electrophoretic deposition parameters. The optical properties of the Ag:Au nanocolloids were analyzed by UV-visible spectroscopy. The elemental composition and chemical states analysis of bimetallic nanoparticles and coatings were done by X-ray photoelectron spectroscopy (XPS), The morphology of the coating was analyzed by scanning electron microscope (SEM) technique. The results show that electrophoretic deposition is effective for developing coatings of bimetallic nanoparticles from their laser-synthesized nanocolloids.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **108** Type: **not specified**

ADRIANA NUÑEZ-CRISTÓBAL: Effect of laser fluency in SI nanocrystal generated by laser ablation.

Friday, 21 February 2020 16:15 (15 minutes)

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **109** Type: **not specified**

DELFINO REYES: Laser ablated/fragmented carbon materials for the production of photoluminescent nanocolloids.

Friday, 21 February 2020 16:30 (15 minutes)

The laser ablation of solids in liquids (LASL) is a novel and growing route for the synthesis of nanomaterials. It is mainly based on two approximations: the laser ablation of solid targets and the laser fragmentation of suspended powders or micromaterials. In both, the laser, solvent and solid target and/or the suspended material can be tuned in order to reach the desired nanomaterials. In this talk, results concerning to the laser ablation of a graphite solid target for the production of carbon nanodots-based nanocolloids or the laser fragmentation of functionalized multiwall carbon nanotubes or carbon black microspheres to synthesize carbon nanocages and/or carbon dots-colloids will be presented and discussed. For all the obtained nanocolloids, the optical features were analyzed by absorbance and photoluminescent spectroscopies while its structural properties of the produced carbon nanomaterials were analyzed through TEM and Raman techniques. The physical mechanism for the formation of the nanomaterials is discussed and their optical and structural features are correlated with the experimental parameters of synthesis.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **110** Type: **not specified**

GABRIEL CASTILLO: Ultrafast laser inscription of photonic devices in transparent dielectrics.

Friday, 21 February 2020 16:45 (30 minutes)

Ultrafast laser inscription is a technique by which pulses from a femtosecond laser, are used to micro-structure the surface or the bulk of solid materials. One of the most interesting features of this kind of lasers is the high peak intensities that can be reached when the delivered pulses are tightly focused. The intensities are typically in the range of 1012 −1015 W/cm2, which can easily induce nonlinear absorption in transparent materials. Therefore, if the laser beam is focused inside a transparent material, nonlinear absorption can be confined to a region near the focal volume allowing ultrahigh precision modifications and 3D microprocessing of the material. In particular, the interaction of femtosecond pulses with transparent dielectrics has attracted a lot of interest in the last two decades, mainly due to the possibility to induce localized refractive index changes to create complex photonic structures inside the material keeping the surface intact. Nowadays, this technique has been consolidated as a three dimensional (3D) photonic device fabrication technology. In this presentation, a brief review of the different techniques used for the fabrication of photonic devices using femtosecond laser pulses and some interesting results such as 3D photonic structures in different materials such as glasses, crystals, and ceramics will be presented.

Session Classification: SHORT TALKS

Track Classification: SYMPOSIUM ON LASER ABLATION

Contribution ID: **111** Type: **not specified**

QUELZATSIN CARRASCO: Phenomenological model for the incoherent addition of two quantum resistors connected in series

Monday, 17 February 2020 19:30 (30 minutes)

Ever since the creation of the integrated circuit in the late 50's and the emergence of nanotechnology, the number of developed nanostructures has been increasing, so much so that at present, nanostructures are viewed as ideal systems for the study of electronic transport; however, a mathematical model that introduces and studies decoherence phenomena into an arbitrary mesoscopic system has not yet been created. This work focuses on studying the behavior of the total conductance of a system through the creation of a phenomenological model that allows the introduction of a local inelastic process in the transmission between two quantum resistors connected in series.

Session Classification: SHORT TALKS