V Leopoldo García–Colín Mexican Meeting on Mathematical and Experimental Physics

El Colegio Nacional, September 9-13, 2013. Mexico City.

Leonardo Dagdug, Leopoldo García–Colín†, Marco Maceda, Moisés Martínez, Marco Vinicio Vázquez, and Alfredo Macías*

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http://weyl.izt.uam.mx/~ gravcos/VLGCMM13/Welcome.html under construction

Luis Felipe Rodríguez and Eusebio Juaristi

El Colegio Nacional
Luis González Obregón 23. Centro Histórico, México, D.F., C.P. 06020, México

(Dated: August 22, 2013)

* Chair

Abstract

The Mexican Meeting, first held in September 2001, is fostered by a group of professors of the Universidad Autonoma Metropolitana, at Iztapalapa Campus, in collaboration with Prof. Leopoldo García–Colín form El Colegio Nacional to set up a forum where promising and important areas of research in Physics and related fields such as Gravitation and Cosmology, Statistical and Biological Physics among others, can be presented and discussed. The main objective is, to open new lines of research for young Mexican scientists and promising graduate students. The meeting consists of five plenary lectures and three parallel symposia: Physics in strong gravitational fields, Transport theory, and Plasma physics. The contents of the meeting will be published in 2013 in three volumes under the same running title by AIP.

The Mexican Meeting is endowed with the Leopoldo García–Colín Medal Award, devoted to recognize outstanding Physicists from abroad working in the subjects of the Meeting.

The event will be held, as the previous four, once again in the beautiful colonial building of El Colegio Nacional (The Mexican Academy of Sciences and Arts) located in the heart of Mexico's City colonial downtown, surrounded by other magnificent constructions of that time. The meeting will be held in the week of 9-13, 2013.

Contents

Schedule for the Symposium on Physics in strong gravitational fields

September	Monday 9	Tuesday 10	Wednesday 11	Thursday 12	Friday 13
09:30 - 10:00	Opening				
Chair:	Alfredo Macías	Leonardo Dagdug	Moisés Martínez	Guillermo Chacón	Darío Núñez
10:00 - 11:00	Remo Ruffini	Jerome Percus	John B. Pendry	James D. Callen	Hansjoerg Dittus
11:00 - 11:30	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Subject:	Black Holes	Numerical Relativity	Binary systems & Grav. waves in strong regime	Gravitational Lensing	Neutron Stars
Chair:	Darío Núñez	Claus Lämmerzahl	Marco Maceda	Darío Núñez	Alfredo Macías
11:30 - 12:30	Pablo Laguna	Luciano Rezzolla	Gerhard Schäfer	Volker Perlick	James Lattimer
12:30 - 13:30	Maria Rodriguez	Miguel Alcubierre	Kostas Kokkotas	Valerio Bozza	Lee Lindblom
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Subject:	Exact Solutions	Scalar Field		Strings & Loops	Main stream topics
Chair:	Jorge Cervantes	Nora Bretón		Alberto García	Marco Maceda
16:00 - 16:30	Alberto García	Darío Núñez	Visit	Luis F. Urrutia	Alberto Guijosa
16:30 - 17:00	Nora Bretón	Alex de la Macorra	to the	Marco Maceda	Tonatiuh Matos
17:00 - 17:30	Efraín Rojas	Jorge Cervantes	Anthropology	David Vergara	Gabriel López
17:30 - 18:00	COFFEE	COFFEE	Museum	COFFEE	COFFEE
Chair:	Marco Maceda	José Socorro		Efraín Rojas	Alfredo Macías
18:00 - 18:30	César López	Juán Barranco		Antonio García	L. García–Colín Medal Lecture
18:30 - 19:00	José Socorro	Argelia Bernal		Hugo Compeán	by
19:00 - 19:30	Oliver Sarbach	Elías Castellanos		Miguel Sabido	Claus Lämmerzahl
19:30 - 20:30			Public Lecture by		Closure and
			Luis Felipe Rodríguez		Honor Wine
20:30			Conference Dinner		

Schedule for the Symposium on Transport Theory

September	Monday 9	Tuesday 10	Wednesday 11	Thursday 12	Friday 13
09:30 - 10:00	Opening				
Chair:	Alfredo Macías	Leonardo Dagdug	Moiśes Martínez	Guillermo Chacón	Darío Núñez
10:00 - 11:00	Remo Ruffini	Jerome Percus	John B. Pendry	James D. Callen	Hansjoerg Dittus
11:00 - 11:30	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Subject:	Electronic, photonic & phononic systems	Electrons and spins	Special materials	Transport on diffusive systems	Diffusion in complex systems
Chair:	Víctor Gopar	Emerson Sadurni	Rafael Méndez	Iván Santamaría	Carlos Ruíz
11:30 - 12:30	Thomas Gorin	Rodolfo Jalabert	José Sánchez-Dehesa	Sergey Bezrukov	Miguel Rubí
12:30 - 13:30	Caio Lewenkopf	César L. Ordóñez	Iván Santamaría	Ralf Metzler	Peter Hänggi
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Chair:	Remigio Cabrera	Antonio Méndez		Marco Vinicio Vázquez	Ramón Castañeda
16:00 - 16:30	Rafael Méndez	Víctor Gopar	Visit to the Anthropology Museum	José Antonio Moreno	David Sanders
16:30 - 17:00				Inti Pineda	Luis Olguín
17:00 - 17:30	José Luis Hernández	Alejandro Kunold		Carlos Ruíz	Guillermo Chacón
17:30 - 18:00	COFFEE	COFFEE		COFFEE	COFFEE
Chair:	Eleuterio Castaño	José Luis Hernández		Marco Vinicio Vázquez	Alfredo Macías
18:00 - 18:30	Emerson Sadurni	Norberto Aquino		Salvador Herrera	L. García–Colín Medal Lecture by Claus Lämmerzahl
18:30 - 19:00	Antonio Méndez	Eleuterio Castaño		Dennis Boyer	
19:00 - 19:30	Gabriela Báez	Remigio Cabrera		L. Vicente Hinestroza	
19:30 - 20:30			Public Lecture by Luis Felipe Rodríguez		Closure and Honor Wine
20:30			Conference Dinner		

Schedule for the Symposium on Fundamentals of Plasma Physics

September	Monday 9	Tuesday 10	Wednesday 11	Thursday 12	Friday 13
09:30 - 10:00	Opening				
Chair:	Alfredo Macías	Leonardo Dagdug	Moisés Martínez	Guillermo Chacón	Darío Núñez
10:00 - 11:00	R. Ruffini	J. Percus	J. B. Pendry	J. Callen	H. Dittus
11:00 - 11:30	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Subject:	Fundamentals of Plasma Physics	Relativistic & Astrophysical Plasmas I	Astrophysical Plasmas	Relativistic & Astrophysical Plasmas II	Relativistic Plasmas
Chair:	A. Sandoval	A. L. García	G. Chacón	G. Chacón	A. L. García
11:30 - 12:30	P. Romatschke	L. F. Rodríguez	W. Lee	E. Calzetta	G. M. Kremer
12:30 - 13:30	J. Callen	H. Andréasson	S. Lizano	G. Wolschin	P. Van
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Chair:	A. Sandoval	A. L. García		A. L. García	A. Sandoval
16:00 - 17:00	J. Martinell	A. Raga	Visit	E. Vázquez	J. A. Ayala
17:00 - 17:30	A. Méndez	A. Sandoval	to the	D. Brun	V. Moratto
17:30 - 18:00	COFFEE	COFFEE	Anthropology	COFFEE	COFFEE
Chair:	G. Chacón	G. Chacón	Museum	A. Sandoval	Alfredo Macías
18:00 - 19:00	J. Herrera	R. Sussman		O. López-Cruz	L. García–Colín Medal Lecture
					by
19:00 - 19:30	A. M. Juárez				Claus Lämmerzahl
19:30 - 20:30			Public Lecture by Luis Felipe Rodríguez		Closure and Honor Wine
20:30			Conference Dinner		

I. PLENARY SPEAKERS

- Remo Ruffini, University La Sapienza and ICRANet, Roma, Italy.

  E–mail: ruffini@icra.it

  TITLE OF THE TALK: SUPERNOVAE AND GAMMA RAY BURSTS :THE MOMENT OF FORMATION OF A BLACK HOLE AND A NEWLY BORN NEUTRON STAR

  Abstract: The recent evidence of the new paradigm of the formation of a Black hole induced by the occurrence of a supernova in a binary system formed by the core of an evolved massive star and a neutron star is presented. The fundamental physics related to the final evolution of stars and new regimes both in Black Hole Physics and Neutron stars will be reviewed.

- Jerome K. Percus, Courant Institute of Mathematical Sciences, New York University, USA.

  E–mail: percus@cims.nyu.edu

  TITLE OF THE TALK: MOLECULAR TRANSPORT UNDER TIGHT CONFINEMENT

  Abstract: When a tubular channel is so narrow that the molecules of a fluid flowing through it cannot pass each other, we are in the realm of single file flow. Here, relative to the dynamics of an isolated particle in the channel, that of a tagged particle hemmed in by its neighbors must be greatly retarded, and the resulting time of its passage through the channel anomalously large. Our aim is to quantify this type of situation for increasingly complex tubular environment. In all cases, we will skimp on details and focus on the qualitative consequences of the analysis.

  We first attend to just what kind of basic one-particle dynamics is involved, especially with non-uniform channels and external forces. We then proceed to idealized point particles on an infinite line, and extend the analysis by contracting the tube to a ring. This is an entree to finite channels, and we will see the effect of possible two-particle passing, as well as model input and output components. Finally, the theoretical "technology" involved will be applied to networks of channels, occurring both in porous media and, on a larger spatial scale, in designed micro-environments.

- John B. Pendry, Department of Physics, Faculty of Natural Sciences, Imperial College, London, UK.

E–mail: j.pendry@imperial.ac.uk

TITLE OF THE TALK: METAMATERIALS AND THE SCIENCE OF INVISIBILITY

Abstract: Electromagnetism encompasses much of modern technology. Its influence rests on our ability to deploy materials that can control the component electric and magnetic fields. A new class of materials has created some extraordinary possibilities such as a negative refractive index, and lenses whose resolution is limited only by the precision with which we can manufacture them. Cloaks have been designed and built that hide objects within them, but remain completely invisible to external observers. The new materials, named metamaterials, have properties determined as much by their internal physical structure as by their chemical composition and the radical new properties to which they give access promise to transform our ability to control much of the electromagnetic spectrum.

- James D. Callen, Department of Engineering Physics, University of Wisconsin, Madison, USA.

E–mail: callen@engr.wisc.edu

TITLE OF THE TALK: COLLISIONAL EFFECTS IN LOW COLLISIONALITY PLASMAS

Abstract: Plasma kinetic theory: In the Klimontovich approach the species microscopic distribution function is the sum over its charged particles, which are taken to be delta functions in 6D $(\mathbf{x}, \mathbf{v})$ *phase space along their particle trajectories. In the non-relativistic limit the trajectories are governed by Newton's equations of motion. In addition, charged particles suffer cumulative small-angle Coulomb collisions that produce the collision operator* $\mathcal{C}\{f\}$*, which is a diffusion operator in velocity space. The resultant plasma kinetic equation (PKE) with a Lorentz collision operator* $\mathcal{C}_{\mathrm{L}}\{f\}$ *is*

$$\frac{df}{dt} \equiv \frac{\partial f}{\partial t} + \frac{\partial}{\partial \mathbf{x}} \cdot \mathbf{v} f + \frac{\partial}{\partial \mathbf{v}} \cdot \left(\frac{\mathbf{F}}{m} f \right) = \mathcal{C}_{\mathrm{L}}\{f\} \equiv \frac{\nu}{2} \frac{1}{\sin\vartheta} \frac{\partial}{\partial \vartheta} \left(\sin\vartheta \frac{\partial f}{\partial \vartheta} \right), \quad \mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}), \tag{1}$$

in which $\vartheta \equiv \sin^{-1} v_{\perp}/v$ *is the pitch-angle in velocity space. The first order partial differential operator on the left hand side of (1) is known as the "collisionless" Vlasov operator. Inclusion of the Coulomb collision operator causes the PKE to become a (diffusive) parabolic second order partial differential equation. In low collisionality (small* ν*) plasmas, Coulomb collisions induce pitch-angle diffusion through a small*

angle $\delta\vartheta \sim \sqrt{\nu t} \ll 1$, which causes the PKE to exhibit a singular solution of width $\sqrt{\nu/\omega}$ around any velocity where $df/dt \sim i(\mathbf{k}\cdot\mathbf{v}-\omega)f \sim 0$. This singular layer solution provides the Coulomb-collision-induced irreversibility that yields Landau damping, which was originally obtained by invoking causality through the use of the Laplace transform procedure.

Fluid moment equations: The velocity-space moments $\int d^3v\,(1, \mathbf{v}, v^2)$ of (1) yield fluid moment equations for the species density, momentum and energy. These equations are exact but require specification of closure moments for the heat flux $\mathbf{q}$ and stress π to be complete. For collisional magnetized plasmas the needed closures are provided in the Braginskii [1] equations. Transport time scale equations for the flux-surface-average densities, poloidal and toroidal flows, and temperatures in tokamak plasmas have been developed [2] in terms of yet to be specified closure moments.

Closures for tokamak plasmas: Some useful closures have been developed for low collisionality tokamak plasmas on various important time scales: 1) collision time scale parallel viscous damping force [3] caused by flow-carrying untrapped particles colliding with a small fraction $\delta\vartheta \sim \sqrt{\epsilon} \ll 1$ of trapped particles; 2) transport time scale neoclassical toroidal viscous (NTV) damping [4] induced by drift-time-scale 3D field effects on "banana" drift orbits caused by collisional scattering of trapped particles; and 3) transport time scale effects caused by 3D magnetic field flutter effects [5] on the parallel flow and heat flow of barely passing electrons and the radial transport they induce.

Open issues: While Braginskii closures are applicable for all collisional plasmas, low collisionality closures for many effects (e.g., microturbulence) in 3D magnetized plasmas remain to be developed. Also, little work has been done on low collisionality effects and closures for relativistic plasmas.

**Research supported by U.S. DoE grants DE-FG02-86ER53218 and DE-FG02-92ER54139.*

[1] S.I. Braginskii, "Transport Processes In A Plasma," in Reviews of Plasma Physics, edited by M.A. Leontovich, (Consultants Bureau, New York, 1965), Vol. I, p 205.

[2] J.D. Callen, C.C. Hegna, and A.J. Cole, "Transport equations in tokamak plasmas," Phys. Plasmas **17**, *056113 (2010).*

[3] See for example A.L. Garcia-Perciante, J.D. Callen, K.C. Shaing, and C.C. Hegna, "Time-dependent neoclassical viscosity," Phys. Plasmas **12**, *052516 (2005) and references cited therein.*

[4] See references cited in J.D. Callen, "Effects of 3D magnetic perturbations on toroidal plasmas," Nucl. Fusion **51**, *094026 (2011).*

[5] J.D. Callen, A.J. Cole, and C.C. Hegna, "Resonant-magnetic-perturbation-inducd plasma transport in H-mode pedestals," Phys. Plasmas **19**, *112505 (2012).*

- Hansjörg Dittus, DLR (German Space Agency), Bremen, Germany.
E–mail: Hansjoerg.Dittus@dlr.de
TITLE OF THE TALK: SPACECRAFTS AS TOOLS FOR MODERN EXPERIMENTAL PHYSICS
Abstract: Enhanced sensor technology and growing precision in satellite tracking and satellite attitude and orbit control enable more and more experiments to explore the microscopic and macroscopic structure of our universe and to learn about its underlying physics laws. These experiments are complementary to those which can be carried out on earth or could open a completely new parameter space due to the unique space environment.

Summarizing results as well as recent and present project proposals, I like to give an overview about the possibilities within the framework of the existing international space programmes.

II. PUBLIC LECTURE

- Luis Felipe Rodríguez (El Colegio Nacional, Centro de Radioastronomía y Astrofísica campus Morelia, UNAM, México).
E–mail: l.rodriguez@crya.unam.mx
TITLE OF THE TALK: HOYOS NEGROS DE DIFERENTES MASAS
Abstract: A principios del siglo XX Albert Einstein propuso una nueva manera de ver a la fuerza de gravedad, expresada en la teora general de la relatividad. Una prediccin de esta teora es que podran existir los objetos que ahora conocemos como hoyos negros: regiones en el espacio en las que la fuerza de gravedad es tan grande que

ni la luz puede escapar de ellas. Las condiciones requeridas para formar un hoyo negro son tan extremas que por mucho tiempo se crey que eran simplemente una curiosidad matemtica. Sin embargo, a partir de la segunda mitad del siglo XX se ha acumulado evidencia que apoya la existencia de hoyos negros en el contexto astronmico. Existen en dos variedades: los hoyos negros supermasivos que existen solo en los centros de las galaxias y los hoyos negros estelares que resultan de la muerte de una estrella y que se distribuyen por toda la Galaxia. Repasaremos la historia de los hoyos negros astronmicos y como se cree que se forman y presentaremos algunos de los temas que en este momento se investigan, los cuales incluyen la determinacin precisa de su masa y rotacin, la bsqueda de hoyos negros de masa intermedia, y el aumento en el brillo de los hoyos negros supermasivos si atrapan gas o inclusive una estrella del medio circundante.

III. MEDAL LECTURE

The organizers of the Leopoldo García–Colín Mexican Meeting on Mathematical and Experimental Physics established the Leopoldo Garca–Coln Medal every three years, starting 2001. With this distinction we wish to recognize outstanding international scientists, for their contributions to the development of science. Its main purpose is to promote both the quality and the scope of theoretical and/or experimental Physics among students and young staff of these areas fostered in the Physics Department. This inspiration, we hope, will be strongly motivated by the scientific contributions of the laureate.

The commemorative Leopoldo Garcia–Colin meeting's medal was awarded in 2001 to Prof. Nicholas Van Kampen (Utrecht) for his outstanding contributions to the field of statistical mechanics. In 2004 it was awarded to Prof. Michael Duff (Imperial Colleage) for his work on unified field theories and strings. In 2007 such honor was bestowed upon Prof. Victor Márquez (NIH) for his valuable contributions in cancer research. In 2010 Prof. George Weiss (NIH) was awarded with the meeting medal for his contributions to the field of Biological Physics and Chemistry. In 2013 Prof. Claus Lämmerzahl (ZARM) is the Medal winner for his outstanding contributions to the confrontation of fundamental physics with experiments.

- Claus Lämmerzahl (ZARM, University of Bremen, Germany).

E–mail: laemmerzahl@zarm.uni-bremen.de

Title of the talk: Motion in space and time

Abstract: The properties of space and time can be explored by the motion of particles. This includes the motion of pointlike test particles around black holes where general relativistic effects will show up like perihelion shift, Lense–Thirring effect, and light deflection. Based on that we also can discuss phenomena like the shadow of black holes and the light sphere surrounding black holes. More exotic effects are the motion on orbital cones, the travel into other universes, time travel, geodetic incompleteness, etc. Further important examples are the motion of test bodies with structure like spin and mass multipole moments which is much more complicated than the motion of point particles. An even more complicated example of particle dynamics are binary systems with comparable masses.

These considerations have applications to astronomy, e.g., to the motion of pulsars around supermassive black holes and to binary pulsars. Corresponding observations will soon give the best tests of General Relativity including tests of modified theories of gravity and - related to that - tests of the no-hair theorem for black holes and tests of the Equivalence Principle in the strong gravity regime. Further issues are chaos, the calculation of gravitational wave templates, the back reaction of gravitational radiation on the motion of binary systems and the detection of gravitational waves through binary systems.

All these considerations are timely due to upcoming new high precision observatories like the Square Kilometre Array SKA, Black Hole imaging observatories like GRAVITY or EHE, and others.

IV. SYMPOSIUM ON PHYSICS IN STRONG GRAVITATIONAL FIELDS

Program Committee:

- Marco Maceda.
  E–mail: mmac@xanum.uam.mx
- Darío Núñez.
  E–mail: nunez@nucleares.unam.mx
- Alfredo Macías.
  E–mail: amac@xanum.uam.mx

A. Black Holes

1. Plenary Talks

- Pablo Laguna. Georgia Institute of Technology, Atlanta. USA.
  E–mail: plaguna@gatech.edu
  Title of the talk: Fireworks from Massive Binary Black Hole Mergers
  Abstract: Modeling the late in-spiral and merger of supermassive black holes is central to understanding accretion processes and the conditions under which electromagnetic emission accompanies gravitational waves. In this regime, magneto-hydrodynamic numerical relativity simulations are needed to investigate how electromagnetic signatures correlate with black hole spins, mass ratios, and the gaseous environment. I will review the current status of simulations of binary black holes mergers in astrophysical environments.
- Maria J. Rodriguez, Harvard University, Department of Physics. Cambridge. USA.
  E–mail: mjrodri@physics.harvard.edu
  Title of the talk: Black Hole Scattering
  Abstract: The scattering process of any field by a black hole spacetime is characterized by the scattering coefficients that have been only fully understood in special cases the low frequency regimes. A deeper understanding of the scattering coefficients in

other regimes may be crucial to the problems in Kerr/CFT, complex analysis and astrophysics. We probe into the black hole scattering by using new analytical and numerical methods, which are in good agreement with the previous known results. These observations, valid in full generality, provide new insights into the properties of the scattering coefficients and their link to the global information of the wave equation encoded in the monodromies.

2. Short Talks: Exact solutions

1. Alberto García, CINVESTAV–IPN, México
   E–mail: aagarcia@fis.cinvestav.mx
   Title of the talk: Scalar Field Non–minimally Coupled to (2+1) Gravity; Rotating Black Hole
   Abstract: A stationary cyclic symmetric black hole solution for a scalar field non–minimally coupled to (2+1)–dimensional gravity is given. The quasi–local momentum, energy and mass are evaluated; they occur to be asymptotically similar to the ones of the rotating anti–de–Sitter black hole solution with a contribution due to the angular momentum parameter. The algebraic structure of the Ricci, energy-momentum, and Cotton tensors is established.

2. Nora Bretón, CINVESTAV–IPN, México
   E–mail: nora@fis.cinvestav.mx
   Title of the talk: On the stability of the Bardeen Black hole
   Abstract: Standard tests of local thermodynamical stability cannot be applied to black holes, being nonextensive, nonadditive thermodynamical systems. The microcanonical stability and its relation to black hole thermodynamics has been addressed using the Poincar'e method of stability, that relates changes in stability to the existence of turning points in conjugated diagrams. Using this method we analyze the stability of the regular magnetic Bardeen black hole, that is an exact solution to the Einstein equations coupled to a nonlinear electromagnetic field. Then, comparison is done with the stability of the solution under field perturbations.

3. Efraín Rojas, University of Veracruz, México

E–mail: efrojas@uv.mx

Title of the talk: Born-Infeld extension of Lovelock brane gravity

Abstract: We present a Born-Infeld type theory to describe the evolution of p-branes propagating in an $N = (p+2)$-dimensional Minkowski spacetime. The expansion of the BI-type volume element gives rise to the (p+1) Lovelock brane invariants associated with the worldvolume swept out by the brane. Contrary to the Lovelock theory in gravity, the number of Lovelock brane Lagrangians differs in this case, depending on the dimension of the worldvolume as a consequence that we consider the embedding functions, instead of the metric, as the field variables. In addition, we briefly discuss on the connection of this model with the Galileon field theory.

4. César López, ICN–UNAM, México

   E–mail: cesar.slm@correo.nucleares.unam.mx

   Title of the talk: Thermal dynamics in general relativity and the inertial properties of heat

   Abstract: In this talk I will present a covariant formulation of thermodynamics in the context of general relativity. I will build on the dynamical equations to produce a Cattaneo–like constitutive equation. Finally, I will provide examples of the thermal properties of some exact solutions.

5. José Socorro, UGTO, México.

   E–mail: socorro@fisica,ugto.mx

   Title of the talk: Classical solutions using Lagrange-Charpit method

   Abstract: We take a Bianchi I metric in the Hamilton-Jacobi scheme and we present the Lagrange-Charpit approach in order to find classical solutions for all values of the barotropic parameter γ, in self creation cosmology.

6. Oliver Sarbach, University of Michoacán, México

   E–mail: sarbach@ifm.umich.mx

   Title of the talk: Relativistic Kinetic Theory from a Tangent Bundle Perspective

   Abstract: We present a brief introduction to the general relativistic kinetic theory of gases with emphasis on the underlying mathematical structure of the theory. In particular, we discuss in detail the geometric properties of the tangent bundle and

show how they naturally lead to the Liouville vector field. The corresponding flow, when projected onto the base manifold, generates geodesic motion. When the flow is restricted to a future mass shell, its projection describes a family of future-directed timelike geodesics. A simple gas is described by a distribution function on the mass shell, satisfying the Boltzmann equation. Fibre integrals of the distribution function determine the particle current density and the stress-energy tensor. We show that the stress-energy tensor satisfies the familiar energy conditions and that both the current and stress-energy tensor are divergence-free. Finally, we discuss the imposition of symmetries on the tangent bundle and present some simple applications of our formalism.

B. Numerical Relativity

1. Plenary Talks

- Luciano Rezzolla, Max–Planck–Institute for Gravitational Physics. Albert-Einstein-Institute, Golm. Germany.
E–mail: luciano.rezzolla@aei.mpg.de
TITLE OF THE TALK: USING NUMERICAL RELATIVITY TO EXPLORE FUNDAMENTAL PHYSICS AND ASTROPHYSICS
Abstract: Recent years have seen a major progress in numerical relativity and the solution of the simplest and yet among the most challenging problems in classical general relativity: that of the evolution of two objects interacting only gravitationally. I will review the results obtained so far when modeling binaries of black holes or of neutron stars and also discuss the impact these studies have in detection of gravitational-waves, in astrophysics, and in our understanding of general relativity.

- Miguel Alcubierre, ICN–UNAM, México
E–mail: malcubi@nucleares.unam.mx
TITLE OF THE TALK: RESONANT CONFIGURATIONS OF MASSIVE SCALAR FIELDS AROUND A SCHWARZSCHILD BLACK HOLE
Abstract: In this talk I will discuss the problem of the Klein-Gordon equation in the background spacetime corresponding to a Schwarzschild black hole. In particular, I

will concentrate on the existence of resonant quasi-stationary solutions trapped on the potential well. This problem can be studied with different techniques, both analytical and numerical. Such configurations, apart from being of interest in themselves, can have possible astrophysical applications, since one can show that for some region of the parameter space they can survive for cosmological times"

2. Short Talks: Scalar Field

1. Dario Núñez, ICN–UNAM, México
   E–mail: nunez@nucleares.unam.mx
   Title of the talk: On the nature of dark matter
   Abstract: In this talk, we present the three different concepts used to describe the dark matter nature: as a fluid, as a collection of particles, and as a scalar field. Thus, the dark matter dynamics are described by the Euler equation, the Vlasov equation or the Klein-Gordon equation. We discuss similarities and differences among the three description, with some warnings on the possible problems of using one description within the other one's realm. We finish discussing possible phenomena which could have different observational consequence depending on which concept is used to describe the dark matter.

2. Axel de la Macorra, IFUAM, México
   E–mail: macorra@fisica.unam.mx
   Title of the talk: Bound Dark Matter and Dark Energy from same Gauge Group
   Abstract: We present the study of Bound Dark Matter BDM and Dark Energy arising from gauge theory in which the mass of these particles is due to bound energy, as in QCD. The composite fermions give BDM while the composite scalars the Dark Energy. We determine the free parameters of the model using cosmological data and galactic rotation curves.

3. Jorge Cervantes, ININ, México
   E–mail: jorge.cervantes@inin.gob.mx
   Title of the talk: Cosmological phase space analysis of the $F(X)-V(\Phi)$

SCALAR FIELD AND BOUNCING SOLUTIONS

Abstract: We analyze the dynamical system defined by a universe filled with a barotropic fluid plus a scalar field with modified kinetic term of the form $L = F(X) - V(\Phi)$. *After a suitable choice of variables that allows us to study the phase space of the system, we obtain the critical points and their stability. We find that some of them reduce to the ones defined for the canonical case when F(X)=X. We also study the field energy conditions to have a nonsingular bounce.*

4. Juán Barranco, University of Guanajuato, México

E–mail: jbarranc@fisica.ugto.mx

TITLE OF THE TALK: COMPACT STARS MADE OF DARK MATTER

Abstract: We construct self-gravitating systems made of dark matter. The characteristics of such "dark stars" depend strongly on the nature of the dark matter candidate. For instance, we will show that in the case of the axion, the self-gravitating system made of axions have asteroid-size masses and radii of a few meters. On the other hand, extremely light scalar fields may form boson stars as big as the dark matter halo or in other cases, they may form boson stars as compact and heavy as super-massive black hole candidates. By employing available astronomical observations we obtain constraints on the mass of the ultra-light scalar fields and its self-interacting coupling constant. Finally, we explore other astrophysical scenarios where such dark stars may produce signals that eventually could shed some light about the nature of dark matter.

5. Argelia Bernal, CINVESTAV–IPN, México

E–mail: argebernal@yahoo.com

TITLE OF THE TALK: SCHWARZSCHILD BLACK HOLE'S SCALAR WIGS: IMPLICATIONS FOR SCALAR FIELD DARK MATTER MODELS

Abstract: According to No-hair theorems, static, spherically symmetric, asymptotically flat black hole space-times with a non-trivial scalar field distribution can not exist in nature, i.e. Schwarzschild black holes can not have scalar hair. However those theorems do not exclude that long-lived scalar field distributions can exist around Schwarzschild black holes. In fact we have shown that there exist distributions, the so called quasi-resonant modes, that can survive for arbitrarily long times, provided the black hole or the scalar field mass is small enough. Moreover, we shown that at large

times in the evolution, an arbitrary initial scalar field distribution can be described as a superposition of quasi-resonant modes.

These results are discussed in the context of ultra-light Scalar Field Dark Matter Models, which assume that the dark matter halos are formed by a classical scalar field configuration. Given the fact that super-massive black holes seem to exist at the center of most galaxies, our results give some support to the survival of scalar field halos around a Schwarzschild black hole for cosmological times.

6. Elías Castellanos, CINVESTAV–IPN, México
E–mail: ecastellanos@fis.cinvestav.mx
Title of the talk: Scalar fields and Bose–Einstein Condensates
Abstract: We analyze the consequences caused by a thermal bath upon the properties associated to the symmetry breaking of scalar fields with one-loop correction potential. Concerning the non–relativistic regime associated with the aforementioned system, we calculate the shift in the condensation temperature caused by the thermal bath, assuming a harmonic oscillator type potential. Additionally, we show that there is a remarkable analogy between the Klein—Gordon equation for a test scalar field in a curved background, and the Gross–Pitaevskii equation for a Bose–Einstein condensate trapped by an external potential. It is interesting to stress the fact that the gravitational background provides a kind of confining potential, in some cases, for the scalar field.

C. Binary systems and gravitational waves in strong regime

1. Plenary Talks

- Gerhard Schaefer, Friedrich Schiller-University Jena. Theoretisch-Physikalisches Institut. Jena. Germany.
E–mail: gos@tpi.uni-jena.de
Title of the talk: Recent achievements in the Hamiltonian treatment of the dynamics and motion of compact binaries in general relativity
Abstract:The current knowledge in the post–Newtonian (PN) dynamics and motion of nonspinning and spinning black–hole and/or neutron-star binaries will be presented

based on the Arnowitt/Deser/Misner Hamiltonain approach to general relativity. The talk will cover the binary dynamics with nonspinning components up to the 4PN order and for spinning binaries up to the next–to–next–to–leading order in the spin-orbit and spin-spin coupling. Radiation reaction will be treated for both nonspinning and spinning binaries. Explicit analytic expressions for the motion will be given, last stable circular orbits will be discussed.

- Kostas D. Kokkotas, Fachbereich Physik. Eberhard Karls Universität Tübingen. Germany.
E–mail: kostas.kokkotas@uni-tuebingen.de
TITLE OF THE TALK: ROTATIONAL & MAGNETIC FIELD INSTABILITIES IN NEUTRON STARS
Abstract: We will review the theory and the latest results concerning the rotational and magnetic field instabilities, their connection to gravitational wave research and the possibilities to trace the details of the neutron star equation of state.

D. Gravitational lensing

1. Plenary Talks

- Volker Perlick, ZARM, University Bremen. Germany.
E–mail: volker.perlick@zarm.uni-bremen.de
TITLE OF THE TALK: GRAVITATIONAL LENSING BEYOND THE WEAK–FIELD APPROXIMATION
Abstract: For many years, the theory of gravitational lensing was almost exclusively done in an approximation formalism assuming that gravitational fields are weak and that bending angles are small. More recently, however, the discovery that there is a black hole at the centre of our galaxy has greatly increased our interest in lensing situations where this approximation is not valid. In this talk I give an overview of gravitational lensing from a spacetime perspective, without any weak-field approximation. Among other things, I will discuss an exact lens equation for spherically symmetric and static spacetimes. The more specific case of black hole lensing will be treated in the subsequent talk by Valerio Bozza.

- Valerio Bozza, INFN, Napoli. Italy

  E–mail: valboz@sa.intn.it

  Title of the talk: Gravitational lens by black holes: the case of Sgr A^*

  Abstract: The strong gravitational fields created by black holes dramatically affect the propagation of photons by bending their trajectories. Gravitational lensing thus stands as the main source of information on the space-time structure in such extreme regimes. We will review the theory and phenomenology of gravitational lensing by black holes, with the generation of higher order images and giant caustics by rotating black holes. We will then focus on Sgr A^*, the black hole at the center of the Milky Way, for which next–to–come technology will be able to reach resolutions of the order of the Schwarzschild radius and ultimately test the existence of an event horizon.

2. Short Talks: Strings and Loops

1. Luis F. Urrutia, ICN–UNAM, México

   E–mail: urrutia@nucleares.unam.mx

   Title of the talk: The Goldstone theorem in non-linear electrodynamics

   Abstract: We provide the first steps in the study of spontaneous Lorentz symmetry breaking induced by non-zero vacuum expectation values of gauge invariant field strengths, as opposed to that produced by non-zero vacuum expectation values of their corresponding potentials, which is usually considered in the literature. The simplest case of the electromagnetic field strength is considered. The gauge invariance of the breaking requires an alternative interpretation of the Goldstone theorem together with the corresponding zero modes, which is given in terms of the properties of a generalized permeability matrix, instead of the mass matrix. The Goldstone modes are identified for the most general available vacua.

2. Marco Maceda, UAM–Iztapalapa, México

   E–mail: mmac@xanum.uam.mx

   Title of the talk: Noncomutative BTZ Spacetime

   Abstract: Using a matrix valued formulation of General Relativity, we discuss a non-

commutative BTZ-like solution based on deformed commutation relations in phase space. It is shown how the noncommutative structure helps to eliminate the horizons of the standard metric among other features.

3. David Vergara, ICN–UNAM, México
E–mail: vergara@nucleares.unam.mx
TITLE OF THE TALK: POLYMER EFFECTIVE ACTIONS USING PATH INTEGRALS
Abstract: In this work, within the formalism of polymer quantum mechanics, we show that using path integrals and the group averaging methods we obtain the Green functions and the effective actions for the free particle, the free relativistic particle and the FRW cosmological model. In the case of the free particle we found that the induced lattice imposed by the polymer implies a limit velocity, bounded by the inverse of the lattice spacing. Furthermore, for the relativistic particle this limit velocity is inferior to the light velocity and this result implies a bound on the scale of the lattice spacing. For massless particles this contribution cancels.

4. José Antonio García, ICN–UNAM, México
E–mail: garcia@nucleares.unam.mx
TITLE OF THE TALK: EXPLORING RELATIVISTIC DYNAMICS USING ADS/CFT
Abstract: The AdS/CFT correspondence is one of the best tools that we have to explore strong coupled quantum field theories. Recently we used this tool to find a generalisation of the Abraham-Lorentz-Dirac equation to the case of a strong coupled SYM, N=4 case. Using this example as guide we explore the physical information provided for us by the AdS/CFT correspondence. We find that AdS/CFT encodes a complete covariantization of the classical non-relativistic result. The covariantization is different from the old proposal of Landau and Lifshitz and also different from the recently proposed relativistic kinematics of Russo and Towsend.

5. Hugo García–Compeán, CINVESTAV–IPN, México
E–mail: compean@fis.cinvestav.mx
TITLE OF THE TALK: QUANTUM HAIR FROM STRING THEORY
Abstract: The proposal for a description of the quantum hair in 4D supersymmetric black holes in string Calabi–Yau (CY) compactifications are given. The quantum hair consisting of electric and magnetic fractional charges in black holes are derived

from periods of the CY's torsion cycles. In the process a K-theory interpretation of the quantum hair in terms of the Atiyah–Hirzebruch spectral sequence is carried out. Finally, the same procedure is considered for torsion cycles of certain generalized CY's threefolds such as half–flat manifolds.

6. Miguel Sabido, UGTO, México
   E–mail: msabido@fisica,ugto.mx
   Title of the talk: On 2+1 gravity and topological M-theory
   Abstract: By starting from Topological M-theory, the exotic and standard actions of 2+1 gravity are derived. This is achieved by using Hitchins functionals as well as a particular construction of the 7-dimensional manifold.

E. Neutron Stars

1. Plenary Talks

- James Lattimer, SUNY, Stony Brook. USA
  E–mail: james.lattimer@stonybrook.edu
  Title of the talk: Observations and the Physics of Neutron Stars
  Abstract: Neutron stars are dense matter laboratories which can be used to test theories of dense matter physics and general relativity. About three dozen neutron star masses are measured with reasonable precision, but, to date, there are no reliable radius measurements of single stars. Nevertheless, radius estimates for nearly a dozen stars are available, and Bayesian analyses of these data suggest that radii are restricted to the range of 10.5 to 12.5 km. In turn, this severely restricts the properties of the nuclear symmetry energy in the vicinity of the nuclear saturation density. Nuclear experiments and systematics also can be used to study the symmetry energy, and it is of great interest that they imply nearly identical behaviors. Observations of the largest mass neutron stars can be used to study the properties of matter at higher densities, and restrict considerably the parameters of quark matter if it is to exist in their interiors. Measurements of moments of inertia in relativistic binaries and tidal and rotational quadrupole moments in neutron star mergers will, in the future, add to these restrictions. Besides observations of structural parameters, observations of

temperatures and ages of more than a dozen neutron stars are available and this data can be compared to theories of neutron star cooling, which yields information concerning the composition in neutron star interiors. In particular, recent observations of the neutron star in the young supernova remnant Cassiopeia A indicate that neutrons are just now becoming superfluid in the interior and that protons have already achieved a superconducting state.

- Lee Lindblom, Cahill Center for Astronomy & Astrophysics 348 Theoretical Astrophysics 350-17 California Institute of Technology 1. USA.
E–mail: lindblom@tapir.caltech.edu
TITLE OF THE TALK: THE RELATIVISTIC INVERSE STELLAR STRUCTURE PROBLEM
Abstract: The observable macroscopic properties of relativistic stars (whose equations of state are known) can be predicted by solving Einstein's equations. For neutron stars, however, our knowledge of the equation of state is poor, so the direct stellar structure problem can not be solved without modeling the highest density part of the equation of state in some way. This talk will describe recent work on developing a model independent approach to determining the high-density neutron-star equation of state by solving an inverse stellar structure problem. This method uses the fact that Einstein's equations provide a deterministic relationship between the equation of state and the macroscopic observables of the stars composed of that material. This talk illustrates how this method will be able to determine the high density part of the neutron-star equation of state with few percent accuracy when high quality measurements of the masses and radii of just two or three neutron stars become available. This talk will also show that this method can be used with measurements of other macroscopic observables, like the masses and tidal deformabilities, which can (in principle) be measured by gravitational wave observations of binary neutron-star mergers.

2. Short Talks: Main stream topics

1. Alberto Güijosa, ICN–UNAM, México
E–mail: alberto@nucleares.unam.mx
TITLE OF THE TALK: ADDING COLOR TO ADS/CFT
Abstract: We point out that the dictionary of the holographic (or AdS/CFT, or

gauge/gravity) correspondence is missing an entry for the color degrees of freedom associated with the global part of the gauge group, and argue that this missing color is incorporated as a hidden index for any string crossing the (acceleration or thermal) horizon.

2. Tonatiuh Matos, CINVESTAV–IPN, México
E–mail: tmatos@fis.cinvestav.mx
TITLE OF THE TALK: BOSE GAS TO BOSE–EINSTEIN CONDENSATE BY THE PHASE TRANSITION OF THE KLEIN–GORDON EQUATION
Abstract: We rewrite the complex Klein-Gordon (KG) equation with a Mexican-hat scalar field potential in a thermal bath with one loop contribution as a new Gross-Pitaevskii-like equation (GP). We interpret it as a charged and finite temperature generalization of the GP equation. We find its hydrodynamic version and using it, we derive its thermodynamics. We translate the breaking of the $U(1)$ local symmetry of the KG field into the new version of the GP equation and show that this mechanism corresponds to a phase transition of the gas into a condensate, superfluid and/or superconductor.

3. Gabriel López, CINVESTAV–IPN, México
E–mail: glopez@fis.cinvestav.mx
TITLE OF THE TALK: THE DISCOVERY OF THE HIGGS BOSON AND THE ORIGIN OF ORDINARY MATTER
Abstract: Almost certainly, an scalar particle with the properties of the Brout-Englert-Higgs boson has been discovered very recently at the CERN Large Hadron Collider. Further experimental studies will help to characterize this particle and establish if it corresponds to the first fundamental scalar field observed in nature. We will present an overview of its genesis, discovery and will explore some possible consequences for particle physics.

F. Schedule for the Symposium on Physics in strong gravitational fields

September	Monday 9	Tuesday 10	Wednesday 11	Thursday 12	Friday 13
09:30 - 10:00	Opening				
Chair:	Alfredo Macías	Leonardo Dagdug	Moisés Martínez	Guillermo Chacón	Darío Núñez
10:00 - 11:00	Remo Ruffini	Jerome Percus	John B. Pendry	James D. Callen	Hansjoerg Dittus
11:00 - 11:30	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Subject:	Black Holes	Numerical Relativity	Binary systems & Grav. waves in strong regime	Gravitational Lensing	Neutron Stars
Chair:	Darío Núñez	Claus Lämmerzahl	Marco Maceda	Darío Núñez	Alfredo Macías
11:30 - 12:30	Pablo Laguna	Luciano Rezzolla	Gerhard Schäfer	Volker Perlick	James Lattimer
12:30 - 13:30	Maria Rodriguez	Miguel Alcubierre	Kostas Kokkotas	Valerio Bozza	Lee Lindblom
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Subject:	Exact Solutions	Scalar Field		Strings & Loops	Main stream topics
Chair:	Jorge Cervantes	Nora Bretón		Alberto García	Marco Maceda
16:00 - 16:30	Alberto García	Darío Núñez	Visit	Luis F. Urrutia	Alberto Guijosa
16:30 - 17:00	Nora Bretón	Alex de la Macorra	to the	Marco Maceda	Tonatiuh Matos
17:00 - 17:30	Efraín Rojas	Jorge Cervantes	Anthropology	David Vergara	Gabriel López
17:30 - 18:00	COFFEE	COFFEE	Museum	COFFEE	COFFEE
Chair:	Marco Maceda	José Socorro		Efraín Rojas	Alfredo Macías
18:00 - 18:30	César López	Juán Barranco		Antonio García	L. García–Colín Medal Lecture
18:30 - 19:00	José Socorro	Argelia Bernal		Hugo Compeán	by
19:00 - 19:30	Oliver Sarbach	Elías Castellanos		Miguel Sabido	Claus Lämmerzahl
19:30 - 20:30			Public Lecture by		Closure and
			Luis Felipe Rodríguez		Honor Wine
20:30			Conference Dinner		

V. SYMPOSIUM ON TRANSPORT THEORY

Program Committee:

- Leonardo Dagdug Lima
  E–mail: dll@xanum.uam.mx
- Angel M. Martínez–Argüello
  E–mail: angelma@xanum.uam.mx
- Moisés Martínez–Mares
  E–mail: moi@xanum.uam.mx
- Marco Vinicio Vázquez
  E–mail: mvazquezg@correo.cua.uam.mx

A. Transport on electronic, photonic and phononic systems

1. Plenary Talks

- Thomas Gorin,
  Departamento de Física, Universidad de Guadalajara, MEXICO.
  E–mail: thomas.gorin@red.cucei.udg.mx
  Title of the talk: Scattering approach to fidelity
  Abstract: In quantum mechanics, the fidelity has started out as an attempt to translate the exponential sensitivity of chaotic dynamics to initial conditions into the quantum realm (Peres 1984). During the last 12 years the fidelity or the quantum Loschmidt echo has been a very active area of theoretical and experimental research. The present talk will focus on the theoretical part and there on the success of random matrix models to describe the fidelity decay of chaotic systems. In particular it will be shown that various exact analytical results derived with the supersymmetry technique can be obtained in a unified manner from the so called Heidelberg model of statistical scattering (Verbaarschot, Weidenmueller, Zirnbauer 1985). Furthermore, I present a generalization of the correspondence between fidelity decay and parametric level correlations (Kohler et al. 2008) to a much broader class of perturbations. At the

end I will discuss new applications in the description of open quantum systems with random matrix environments.

- Caio H. Lewenkopf,
Instituto de Física, Universidade Federal Fluminense, BRASIL.
E–mail: caio@if.uff.br
TITLE OF THE TALK: ELECTRONIC TRANSPORT IN GRAPHENE: INSIGHTS FROM THE THEORY OF MASSLESS DIRAC FERMIONS
Abstract: The remarkable electronic and mechanical properties of graphene pose great challenges to fundamental science research and open possibilities for a large variety of interesting practical applications. For that reason, the research in graphene has developed quickly and currently involves a large community of physicist, chemists, and materials scientists. Graphene is a single-atom thick membrane and its transport properties are governed by the interplay of low-dimensionality, disorder, mechanical dynamics, and electronic interaction effects. In the first half the talk, some properties of the graphene electronic structure will be reviewed. In particular, I will discuss the low energy electronic linear dispersion, characteristic of Dirac fermions, and its relation to peculiar transport proprieties. Next, I will focus on two specific problems currently investigated in my group, namely: (i) Electronic interaction, disorder, and the Kondo effect in graphene, and (ii) Effects of deformations in the transport properties of graphene nanoelectromechanical (NEMs) ribbons.

- Rafael A. Méndez-Sánchez,
Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, MEXICO.
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TITLE OF THE TALK: EXPERIMENTAL STUDIES IN ELASTIC BEAMS AND PLATES
Abstract: We present recent experimental results on the vibrations of elastic beams and plates. On the one hand it is shown that the second Timoshenko spectrum exists beyond the critical frequency. Doublets, instead of single levels, were measured. This is in agreement with the predictions of the Timoshenko beam theory. Waveguides formed with elastic plates were also studied. When the waveguides have bents, trapped states, below the cutoff frequency, are found. The theoretical predictions show excellent agreement with the experimental results.

- José Luis Hernández-Pozos,
Departamento de Física, Universidad Autónoma Metropolitana-Iztapalapa, MEXICO.
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TITLE OF THE TALK: THIN COPPER FILMS IN THE PERCOLATION LIMIT AND ITS POSSIBLE USE AS A MATERIAL WITH EXTRAORDINARY OPTICAL TRANSMISSION
Abstract: It is well known that a thin metal sheet with a periodic array of holes, when illuminated by light, may transmit more light than the usual diffraction theory predicts, this behavior as been termed extraordinary optical transmission (EOT). Although there is still debate about the causes of EOT, it is normally explained in terms of a coupling between the surface plasmon generated by the incoming light and the hole array such that, when its periodicity is the appropriate it allows the flow of energy from one side of the film to the other face facilitated thru the array of pits. In this work we show that a random array of holes which is produced when depositing laser-ablated Copper on a glass substrate near the percolation limit also displays EOT. As explained earlier, as some of the models used to explain EOT rely on the periodicity of the hole array, on the light of these results it might be necessary to modify such models.

- Emerson Sadurni,
Instituto de Física "Luis Rivera Terrazas", Benemérita Universidad Autónoma de Puebla, MEXICO.
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TITLE OF THE TALK: TIME DEPENDENT PROPAGATION IN TWO DIMENSIONAL CRYSTALS: A THEORETICAL STUDY
Abstract: The problem of wave propagation in solids has been approached traditionally in energy or frequency domain. While practical conditions demand such a treatment, here we show that the propagation in time domain can also be treated by analytical methods. By using a recently found propagator in discrete variables we can determine the spreading of localized packets in two dimensional crystals, including triangular and hexagonal lattices.

- José Antonio Méndez-Bermúdez,
Instituto de Física "Luis Rivera Terrazas", Benemérita Universidad Autónoma de Puebla, MEXICO.
E–mail: jmendezb@ifuap.buap.mx
TITLE OF THE TALK: DISORDER TO CHAOS TRANSITION IN THE CONDUCTANCE DISTRIBUTION OF CORRUGATED WAVEGUIDES
Abstract: We perform a detailed numerical study of the distribution of conductances $P(T)$ for quasi-one-dimensional corrugated waveguides as a function of the corrugation complexity (from rough to smooth). We verify the universality of $P(T)$ in both, the diffusive ($\langle T\rangle > 1$) and the localized ($\langle T\rangle \ll 1$) transport regimes. However, at the crossover regime ($\langle T\rangle \sim 1$), we observe that $P(T)$ evolves from the surface-disorder to the bulk-disorder theoretical predictions for decreasing complexity in the waveguide boundaries. We explain this behavior as a transition from disorder to deterministic chaos; since, in the limit of smooth boundaries the corrugated waveguides are, effectively, linear chains of chaotic cavities.

- Gabriela Báez,
Departamento de Ciencias Básicas, Universidad Autónoma Metropolitana-Azcapotzalco, MEXICO.
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TITLE OF THE TALK: SCATTERING OF MECHANICAL WAVES IN ONE DIMENSIONAL ELASTIC CAVITIES: AN EXPERIMENTAL STUDY
Abstract: An experimental study of the transmission and reflection of mechanical waves in a one dimensional elastic cavity in the presence of absorption, is made. The system consists of a cavity connected to a waveguide with an absorbent foam at the end thereof. The experimental setup uses a vector network analyzer and electromagnetic acoustic transducers. Experimental results show that the resonances of the cavity have quality factors of the order of 100. In addition to the resonance curve, the corresponding phase is measured.

B. Electrons and spins

1. Plenary Talks

- Rodolfo Jalabert,
IPCMS - Département Magnétisme des Objets NanoStructurés (DMONS), Université de Strasbourg, FRANCE.
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  TITLE OF THE TALK: TRANSMISSION PHASE AND CONDUCTANCE OF MESOSCOPIC SYSTEMS: CHAOS, INTERACTIONS AND SPIN EFFECTS

  Abstract: The tendency of the last decades to develop smaller and smaller electronic components has driven the attention of condensed matter physicists from micro to nano-structures, and then to molecular conductors. The focus of studies has concomitantly been extended from phase-coherent phenomena, to include the influence of the underlying classical dynamics, and more recently interaction and spin effects. We present some examples of this evolution, illustrating the always-present competition observed in quantum electronic transport between fluctuations and regular behavior, and then we focus in the paradigmatic case of the scattering phase of a quantum dot operating in the Coulomb blockade regime.

  The phase-sensitive experiments performed by embedding a quantum dot in one arm of an interferometer concluded that successive Coulomb-blockade resonance peaks are always in phase. The explanation of this regular behavior has remained as a puzzle for more than a decade. We provide a solution of this puzzle by showing that wave-function correlations existing in chaotic ballistic quantum dots are responsible for the emergence of large universal sequences of in-phase resonances in the short wavelength limit.

  Our results are corroborated by numerics and are in qualitative agreement with existing experiments for the case of quantum dots containing at least a hundred of electrons. These relatively large dots allow for a treatment of the Coulomb blockade physics within a constant charging energy model leading to an effective one-particle description. Smaller dots require going beyond mean-field approaches by including the effect of electronic correlations. We develop a numerical method, based on Density

Matrix Renormalization Group, in order to extract the scattering phase of a strongly correlated quantum dot. We then determine the role of electron-electron interactions and spin for the case of dots with less than ten electrons. Our results show that electronic correlations do not result in the universal behavior of the scattering phase and that small dots are always in the mesoscopic regime of random relative phases.

- César L. Ordóñez,
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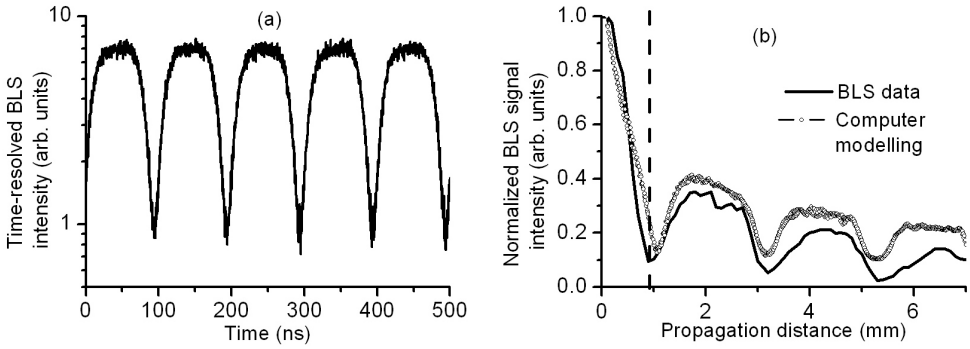
  TITLE OF THE TALK: DIRECT BRILLOUIN LIGHT SCATTERING OBSERVATION OF DARK SPIN-WAVE ENVELOPE SOLITONS TRAVELLING IN YTTRIUM IRON GARNET FILMS
  Abstract: In recent years, dark spin-wave envelope solitons at microwave frequencies have been observed in yttrium iron garnet (YIG) films for various experimental configurations [1-3]. Up to now, however, all these dark soliton results have been based solely on time-resolved microwave data. In this work, time and space resolved Brillouin light scattering (TSR-BLS) techniques have been used for the measurement and characterization of the formation and propagation of spin-wave envelope dark soliton trains in a YIG film-based delay line structure. The solitons were excited through the nonlinear mode beating of two intense CW microwave input signals with slightly different frequencies, along with the resulting induced modulation instability. The TSR-BLS technique permitted the local mapping of space and time profiles at different points along the YIG strip. Graph (a) shows a time-resolved BLS intensity profile of the dark soliton train measured 1 mm away from the input antenna. Graph (b) shows the normalized BLS intensity spatial decay profile for the corresponding CW beat signal, along with a computed response based on the Landau-Ginzburg equation. The vertical dashed line in (b) indicates the transition "boundary" between the nonlinear (left side) and the linear (right side) damping zones. These results comprise the first direct time and space resolved measurements of the spatial evolution of a train of spin-wave envelope dark solitons.



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[3] M. M. Scott, M. P. Kostylev, B. A. Kalinikos, and C. E. Patton, Phys. Rev. B ***71****, 174440 (2005).*

- Víctor A. Gopar,

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  Title of the talk: Quantum transport through disordered systems: conductance via localized and delocalized electrons

  Abstract: Coherent electronic transport through disordered systems, like quantum wires, is a topic of fundamental and practical interest. In particular, the exponential localization of electron wavefunctions–Anderson localization–due to the presence of disorder has been widely studied. In fact, Anderson localization, is not an phenomenon exclusive to electrons but it has been observed in microwave and acoustic experiments, photonic materials, cold atoms, etc. Nowadays, many properties of electronic transport of quantum wires have been successfully described within a scaling approach to Anderson localization.

  On the other hand, anomalous localization or delocalization is, in relation to the Anderson problem, a less studied phenomenon. Although one can find signatures of anomalous localization in very different systems in nature. In the problem of electronic transport, a source of delocalization may come from symmetries present in the system and particular disorder configurations, like the so-called Lvy disorder. We have

developed a theoretical model to describe the statistical properties of transport when electron wavefunctions are delocalized. In particular, we calculate the the distribution of the conductance. We show that only two physical parameters, which can be experimentally obtained, determine the complete conductance distribution.

During recent years, graphene based devices have received a wide attention due to their special electronic properties. We have found that electrons in disordered graphene nanoribbons can be delocalized, near the Fermi energy. We thus have applied our theoretical model to study the statistical properties of the conductance through graphene nanoribbons.

2. Short Talks

- Alejandro Kunold,
Departamento de Ciencias Básicas, Universidad Autónoma Metropolitana-Azcapotzalco, MEXICO.
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  TITLE OF THE TALK: SPIN-DEPENDENT PHOTOCONDUCTIVITY IN NONMAGNETIC SEMICONDUCTORS AT ROOM TEMPERATURE

  Abstract: We present a theoretical study of the spin-dependent photoconductivity in a dilute Nitride GaAsN heterostructures [1]. In this materials the strong localization of the electron's wave function in the deep paramagnetic centers harnesses the spin dependent recombination processes [2,3]. We develop a non linear transport model based on the rate equations for electrons, holes, deep paramagnetic and non paramagnetic centers under CW optical excitation. Particular attention is paid to the role drift and diffusion of charge carriers. We observe that drift and diffusion phenomena play a decisive effect in spin dependent recombination. Under an external magnetic field in Voigt geometry the photoconductivity exhibits a Hanle-type curve whereas the spin polarization of electrons shows two superimposed Lorentzian curves with different widths, respectively related to the recombination of free and trapped electrons [4]. The model is capable of reproducing the most important features of photoluminescence and photocurrent experiments and is helpful in providing insight on the various mechanisms involved in the electron spin polarization and filtering in

GaAsN semiconductors. We show that this devices might provide the means for spin polarization dectection by electrical means.

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  Title of the talk: The role of correlation in the ground state energy of confined helium atom

  Abstract: We analyze the ground state energy of helium atom confined by spherical impenetrable walls, and the role of the correlation energy in the total energy. The confinement of an atom in a cavity is one way in which we can model the effect of the external pressure on an atom. The calculations of energy of the system are carried out by two ways; a) The variational method, and b) Perturbation Theory independent of time. For the variational approach we use generalized Hylleraas functions as a base set. We found that for strong confinement PT gives results that are in agreement with those obtained with the variational method.

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  Title of the talk: Time-diffraction and quantum interference effects in mesoscopic rings

  Abstract: The study of time diffraction effects is an important topic that initially was described Moshinsky some sixty years ago. In the past few years this effect received experimental confirmation not without some controversy. This effect has also inspired

a number of theoretical studies in several different systems, works that will be briefly reviewed in the present work.

The essential point is to study the time dependence of the propagation of a quantum particle that is initially confined to a finite region of space by a shutter that is instantly removed; the subsequent evolution has a mathematical form closely resembling that of space-diffraction of monochromatic light by a semi-infinite plane, but now with time playing the role of space, something that Moshinsky termed time-diffraction. In this problem, the propagation is coherent and as such could be extended to other mesoscopic systems.

In this work we consider the propagation of free electrons on a circular ring threaded by a magnetic flux. The propagation of waves is studied with the Green function written as an infinite sum of one-dimensional Green functions being each shifted an effective angular momentum contribution, and multiplied by a factor due to the magnetic flux. This is applied to study the coherent propagation of an electron initially confined to a finite angular region of the ring by two shutters that, at a given time, are removed at once. The ensuing evolution is a mixture of an infinite number of time-diffraction terms that interfere with each other in a manner mediated by the magnetic flux. In short, we study an Aharonov-Bohm mediated time-diffraction effect, a la Moshinsky, in a closed ring.

To simplify the study we use the so called quantum carpets, i.e., *contour plots of the probability function as a function of position and time. In this way, we can analyze the different symmetries present in the problem. We also discuss extensions to this work to other two-, and three-dimensional model systems, the hope being to open possibilities to the experimental exploration of Moshinskys effects in more general mesoscopic systems.*

- Remigio Cabrera–Trujillo,
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TITLE OF THE TALK: ON THE KINETIC THEORY APPROACH TO THE STOPPING POWER AND THE STUDY OF CHARGE AND ENERGY TRANSFER IN COLLISIONS OF

IONS WITH MATTER

Abstract: In this work, we present advances in the study charge and energy transfer in collisions of heavy ions with atomic and molecular targets. As these processes are not adiabatic, we present a time-dependent theoretical approach were the electron and nuclear dynamics are coupled, the so called END approach. We apply the END approach to the study the cross section for charge transfer, energy loss, and ranges in collision of heavy ions with atomic and molecular targets. In particular, we discuss the kinetic theory model which is based on velocity distribution functions and transport cross sections to correct the energy loss in systems where the target electrons move faster that the projectile. Our results thus contain methodologies of quantum chemistry and transport phenomena for multi-electronic systems. We show results for systems of astrophysics, biological and atmospheric interest, particularly, radiotherapy and dosimetry.

We acknowledge support from DGAPA-UNAM IN-101-611.

C. Special materials

1. Plenary Talks

- José Sánchez-Dehesa,
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  TITLE OF THE TALK: SOUND CONTROL BY ACOUSTIC METAMATERIALS

  Abstract: A review of the recent advances on acoustic metamaterials for the control of sound waves will be presented. Particularly, emphasis will be put on the topic of acoustic cloaking where the fabrication of a functional device is still a challenge. Metamaterials with negative parameters will be also described and how they can be engineered. Finally, metamaterials with near zero dynamical density also offers an interesting variety of potential applications that will be reported.

- Iván Santamaría Holek,
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Title of the talk: Modeling nano-motor operation in biology and nano engineering

Abstract: We discuss the basic mechanisms of operation of two kind of nano-motors. First, we propose a biochemical model providing the kinetic and energetic descriptions of the processivity dynamics of kinesin, myosin and dinein protein motors. This approach is a modified version of hand-over-hand model for kinesin dynamics with a new ingredient: It considers the presence of a competitive inhibition reaction by ADP. We reconstruct the free-energy landscape of the cycle catalyst process and calculate the number of steps given by a single molecular motor as well as the translational velocity as a function of time and ATP concentration. Motor processivity is discussed in quantitative form by using experimental data. We also predict a time duration of collective processes that agrees with experimental reports. Then, we present an powerful model to account for the dynamics of a thermally activated nano-electromechanical device created with two coaxial carbon nanotubes of disparate lengths. The presence of strong thermal inhomogeneities induced motion of the shorter nanotube along the track of the longer nanotube. Our model combines the actions of frictional, Van der Waals, and thermal forces and the effects of noise and is used to reproduce the motions observed in experiments and simulations. The dynamics of the nanomotor reveals the existence of a rich variety of dynamical behaviors and a high sensitivity to noise and initial conditions.

D. Transport on diffusive systems

1. Plenary Talks

- Sergey Bezrukov,
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Title of the talk: Effective mobility, diffusion, and rectification in tubes of periodically varying geometry

Abstract: Transport in systems of varying geometry has become the subject of growing attention among researchers in recent years since such systems are ubiquitous in

biology and technology. Using analytical considerations and Brownian dynamics simulations, we study the effective mobility and diffusion coefficient of a point particle in tubes formed from identical compartments of varying diameter, as functions of the driving force applied along the tube axis. Our focus is on how the driving force dependences of these transport parameters are modified by the changes in the compartment shape. In addition to monotonically increasing or decreasing behavior of the effective mobility in such tubes, we show that it can be non-monotonic and asymmetric in the driving force. When the tube-forming compartment is symmetric, the mobility is indeed a symmetric function of the driving force but is non-monotonic for certain geometries with sharply varying diameter. Compartment asymmetry gives rise to an asymmetric force-dependent mobility. The transition of the force-dependence of the mobility from symmetric to asymmetric behavior results in important consequences for the particle motion under the action of a time-periodic force with zero mean: In a tube formed by moderately asymmetric compartments, the particle under the action of such a force moves unidirectionally with an effective drift velocity that vanishes at small and large values of the force amplitude and has a maximum in between. Thus we demonstrate that the periodically varying tube geometry leads to a number of nontrivial transport effects even in the case of non-interacting particles.

- R. Metzler,
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TITLE OF THE TALK: ERGODICITY VIOLATION AND AGEING IN ANOMALOUS DIFFUSION
Abstract: In 1905 Einstein formulated the laws of diffusion, and in 1908 Perrin published his Nobel-prize winning studies determining Avogadro's number from diffusion measurements. With similar, more refined techniques the diffusion behaviour in complex systems such as the motion of tracer particles in living biological cells or the tracking of animals and humans is nowadays measured with high precision. Often the diffusion turns out to deviate from Einstein's laws. This talk will discuss the basic mechanisms leading to such anomalous diffusion as well as point out its consequences. In particular the unconventional behaviour of non-ergodic, ageing systems will be dis-

cussed within the framework of continuous time random walks. Indeed, non-ergodic diffusion in the cytoplasm of living cells as well as in membranes has recently been demonstrated experimentally.

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2. Short Talks

- José Antonio Moreno Razo,
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  TITLE OF THE TALK: DIFFUSIVITY OF NANOPARTICLES IN NEMATIC LIQUID CRYSTAL MATRIX

  Abstract: We presents results of diffusivity of a nanoparticle suspended in a nematic liquid crystal matrix. By using molecular simulations, the liquid-crystalline solvent is modeled at the level of GayBerne mesogens in the canonical (N, V, T) *ensemble. The mesogen-colloid interaction strength is modeled to induce anchoring effects: from parallel to perpendicular. The mean square displacements and relative colloidal diffusivities are reported for different types of anchoring on the nanoparticle. The GayBerne parametrization is compared with respect to experimental observations, and a specific set of parameters is found to reproduce the characteristic ratio of mesogenic diffusivities observed in experiments. The results presented in this talk provide a means to determine anchoring strength at small length scales, and the parameterizations provided in this work could serve as a starting point to interpret experimental data for nanoparticle suspensions in liquid-crystals at a molecular level.*

- Inti Pineda,
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  TITLE OF THE TALK: PROJECTION OF TWO-DIMENSIONAL DIFFUSION IN NARROW ASYMMETRIC CHANNELS ONTO THE LONGITUDINAL DIRECTION

  Abstract: Diffusive transport of particles is a ubiquitous feature of physical, chemical and biological systems. Typical structures like pores, tubes or fibers, are quasi one-

dimensional. We have to solve $3+1$ or $2+1$ dimensional differential equations to describe correctly transport along them. The so-called Fick-Jacobs approach dramatically simplifies the problem if one assumes that solute distribution in any cross-section of the channel is uniform as at equilibrium [1,2]. This study focuses on the mapping of the diffusion equation in a two-dimensional narrow asymmetric channel of varying cross section onto the longitudinal coordinate. We present a generalization to the case of an asymmetric channel using the projection method introduced earlier by Kalinay and Percus [3, 4]. We derive an expansion of the effective diffusion coefficient $D(x)$ which represents corrections to the Fick-Jacobs equation and contains the well-known previous results as special cases, namely, those obtained by Bradley [5], and more recently by Berezhkovskii and Szabo [6]. Finally, we study numerically some specific two-dimensional asymmetric channel configurations to test and show the broader applicability of this effective diffusion coefficient formula.

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[5] M. R. Bradley, Phys. Rev. E ***80****, 061142 (2009).*

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TITLE OF THE TALK: FALLING IN A SUPERLIGHT GRANULAR MEDIUM

Abstract: When a projectile impacts into a granular medium it stops invariably at some finite depth. Chain forces acting on the object and energy dissipation due to friction are responsible for the stopping effect. Here we challenge such phenomenon by doing penetration experiments and Molecular Dynamics Simulations in 2 and 3D superlight granular systems. Two counterintuitive behaviors are observed: 1) above a critical mass, a projectile impacting into a granular medium endlessly sinks with a terminal velocity as if the medium were a simple fluid [1]; 2) several projectiles

fall through the medium in a collective way following a cooperative dynamics, whose complexity resembles flocking phenomena in living systems [2]. We claim that the observed dynamics might give a clue for advancing the idea that hydrodynamics have an important role in granular systems.

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- Salvador Herrera–Velarde,

  División de Ciencias e Ingeniería, Universidad de Guanajuato, MEXICO.

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  TITLE OF THE TALK: COLLOIDAL SUSPENSIONS IN CONFINEMENT AND UNDER PERIODIC EXTERNAL FIELDS

  Abstract: Colloidal suspensions are made up of mesoscopic objects that, even in the absence of any kind of external perturbation, exhibit interesting static and dynamical properties. However, in confinement, colloidal suspensions show new features that are not typically found in the bulk. Additionally, external fields may induce changes in their phase behavior. In this talk, we will discuss both the structural and dynamic properties of interacting colloids confined in 1D and 2D geometries. Particular emphasis is put on the effect of periodic substrates, the latter ones created, for instance, by the interference of laser beams.

- Dennis Boyer,

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  TITLE OF THE TALK: RANDOM WALKS WITH PREFERENTIAL RETURNS TO SITES VISITED IN THE PAST AS A DESCRIPTION OF ANIMAL MOVEMENTS

  Abstract: Understanding how an animal changes its displacements in relation to its environment is central to several topics in ecology and conservation. In field observations trajectories of high temporal and spatial resolution are often analyzed as standard random walks, and those have been often divided in recent years into two categories:

normal (Brownian-like) or superdiffusive (Lévy-like). However, more sophisticated analysis can be performed to probe memory effects and deviations from Markovian processes in single animal trajectories. We analyze the movements of monkeys (Cebus capucinus) in their habitat and show that they are Brownian at short times and strongly subdiffusive at large times. In addition, their visitation patterns are very heterogeneous in space, like in humans, and characterized by power-law distributions. These properties can be explained with a random walk model with intermittent use of memory at all temporal scales.

- Luis Vicente Hinestroza
  Facultad de Química, Universidad Nacional Autónoma de México, MEXICO
  TITLE OF THE TALK: MONTE CARLO SIMULATIONS OF SURFACE REACTIONS: NO REDUCTION BY CO OR H_2
  Abstract: The development of surface science has given an opportunity to investigate the process of heterogeneous catalysis at a molecular level. In this way there has been great progress in understanding the mechanism of NO decomposition. Modelling has been a very important tool to this goal. In this work we analyze the reactions $NO + H_2$ and $NO + CO$. The extremely narrow production peak of N_2 and CO_2 which occurs in the reaction of $NO + CO$ on Pt(100), a phenomenon known as surface explosion, is studied using a dynamic Monte Carlo method on a square lattice at low pressure under isothermal conditions. The catalytic reduction of nitric oxide by hydrogen over a Pt surface is also studied by using a dynamic Monte Carlo (MC). Using a Langmuir-Hinshelwod mechanism of reaction, a simplified model with only four adsorbed species (NO, H, O, and N) is constructed. The effect on NO dissociation rate, the limiting step in the whole reaction, is inhibited by coadsorbed NO and H_2 molecules, and is enhanced, both by the presence of empty sites and adsorbed N atoms as nearest-neighbors. In these simulations experimental parameters values are included, such as: adsorption, desorption and diffusion of the reactants. The phenomenon is studied changing the temperature in the range of $300 - 550\,K$. The modelling reproduces well observed TPD and TPR experimental results and allow a visualization of the spatial development of the surface explosion as the heating process proceeds and the shrinkage of $NO+H$ regions.

E. Diffusion in complex systems

1. Plenary Talks

- Miguel Rubí,

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  TITLE OF THE TALK: CONFINED BROWNIAN RATCHETS

  Abstract: We analyze the dynamics of Brownian ratchets in a confined environment. The motion of the particles is described by a Fick-Jacobs kinetic equation in which the presence of boundaries is modeled by means of an entropic potential. The cases of a flashing ratchet, a two-state model and a ratchet under the influence of a temperature gradient are analyzed in detail. We show the emergence of a strong cooperativity between the inherent rectification of the ratchet mechanism and the entropic bias of the fluctuations caused by spatial confinement. Net particle transport may take place in situations where none of those mechanisms leads to rectification when acting individually. The combined rectification mechanisms may lead to bidirectional transport and to new routes to segregation phenomena. Confined Brownian ratchets (CBR) could be used to control transport in mesostructures and to engineer new and more efficient devices for transport at the nanoscale.

- Peter Hänggi,

  Institute of Physics, University of Augsburg , GERMANY.

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  TITLE OF THE TALK: ANOMALOUS HEAT DIFFUSION

  Abstract: We consider generally anomalous, i.e. normal, sub-diffusive and super-diffusive energy spread in solid phases of the mean square deviation MSD, i.e. the $MSD(t) = [\langle x(t)^2\rangle - \langle x(t)\rangle^2]$ grows as t^β upon increasing time, of the non-equilibrium energy excess distribution $\rho_E(x,t)$, as induced by a small excess energy perturbation distribution away from thermal equilibrium. The associated total thermal heat flux autocorrelation function $C_{JJ}(t)$ is then shown to obey rigorously the intriguing re-

lation: $d^2MSD(t)/dt^2 = 2C_{JJ}(t)/(k_BT^2c)$, where c denotes the specific volumetric heat capacity. Its first integral then assumes a time-local Helfand-moment relation with a chosen cut-off time $t_{\text{cut-off}} = t_S$, which is determined by corresponding signal velocity for heat transfer. Given next the premise that the averaged heat flux is indeed also governed by anomalous heat conductivity, anomalous energy diffusion scaling necessarily determines a corresponding anomalous thermal conductivity scaling for its size-dependence. For normal diffusion the conductivity becomes size-independent (i.e. a Fourier Law) while for super-diffusion it approaches a vanishing heat conductivity with increasing size L.

2. Short Talks

- David P. Sanders,
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TITLE OF THE TALK: DIFFUSION IN QUASIPERIODIC BILLIARD MODELS
Abstract: We introduce a simple method to understand quasiperiodic billiard models, consisting of fixed, hard obstacles arranged in a quasiperiodic lattice. This method, which is based on "undoing" the standard projection method used to construct quasi-lattices, leads to (i) a simple numerical algorithm to integrate billiard trajectories; (ii) a definition of uniform distribution, and hence averages; and (iii) a simple method to demonstrate the existence of channels, i.e. infinitely long regions passing through the quasiperiodic crystal in which particles may travel ballistically without ever colliding with an obstacle. These lead to a range of diffusive behaviours, including weak super-diffusion in the presence of these channels.

- Luis Fernando Olguín Contreras,
Facultad de Química, Universidad Nacional Autónoma de México, MEXICO.
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TITLE OF THE TALK: MICROFLUIDIC DROPLETS
Abstract: Microfluidic droplets are picoliter-nonoliter size segments of certain fluid separated by another continuous immiscible fluid within a microfluidic channel. The droplets are generated by shear forces and the interfacial tension formed when the

continuous flows of the immiscible fluids (typically water and oil) intersect in a microchannel junction. The microdroplets are highly homogeneous in size and shape and have been extensively used to carry out chemical and biological assays as they have the capacity to transport reagents and products in the microchannels with minimal dispersion. Some important aspects of the physics involved in droplet formation, its movement and the retention or release of its contents will be presented with emphasis on transport phenomena.

- Guillermo Chacón Acosta,
Departamento de Matemáticas Aplicadas y Sistemas, Universidad Autónoma Metropolitana-Cuajimalpa, MEXICO.
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  TITLE OF THE TALK: EFFECTIVE ONE-DIMENSIONAL DIFFUSION ON A CURVED SURFACE

  Abstract: This study focuses on the derivation of a general effective diffusion coefficient to describe the two dimensional (2D) diffusion in a narrow and smoothly asymmetric channel of varying width that lies on a curved surface, in the simple diffusional motion of noninteracting pointlike particles under no external field. To this end we extend the generalization of the Kalinay-Percus projection method [1,2] for the asymmetric channels introduced in [3], to project the anisotropic two dimensional diffusion equation on a smooth curved manifold, into an effective one dimensional generalized Fick-Jacobs equation that is modified due to the curvature of the surface.

  The lowest order in the perturbation parameter, corresponding to the Fick-Jacobs equation contains an extra term that accounts for the curvature of the surface by the Christoffel symbols. We found explicitly the first order correction for the invariant effective concentration, which is defined as the correct marginal concentration in one variable, and we obtain the first approximation to the effective diffusion coefficient analogous to Bradleys coefficient as a function of metric elements of the manifold.

  Straightforwardly we study the perturbation series up to the n-th order, and we derive the full effective diffusion coefficient for the two dimensional diffusion in a narrow asymmetric channel, that have modifications due to the curved metric.

  Finally, we present some examples of symmetric surfaces and we study some specific

channel configurations on them.

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F. Schedule for the Symposium on Transport Theory

September	Monday 9	Tuesday 10	Wednesday 11	Thursday 12	Friday 13
09:30 - 10:00	Opening				
Chair:	Alfredo Macías	Leonardo Dagdug	Moiśes Martínez	Guillermo Chacón	Darío Núñez
10:00 - 11:00	Remo Ruffini	Jerome Percus	John B. Pendry	James D. Callen	Hansjoerg Dittus
11:00 - 11:30	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Subject:	Electronic, photonic & phononic systems	Electrons and spins	Special materials	Transport on diffusive systems	Diffusion in complex systems
Chair:	Víctor Gopar	Emerson Sadurni	Rafael Méndez	Iván Santamaría	Carlos Ruíz
11:30 - 12:30	Thomas Gorin	Rodolfo Jalabert	José Sánchez-Dehesa	Sergey Bezrukov	Miguel Rubí
12:30 - 13:30	Caio Lewenkopf	César L. Ordóñez	Iván Santamaría	Ralf Metzler	Peter Hänggi
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Chair:	Remigio Cabrera	Antonio Méndez		Marco Vinicio Vázquez	Ramón Castañeda
16:00 - 16:30	Rafael Méndez	Víctor Gopar	Visit to the Anthropology Museum	José Antonio Moreno	David Sanders
16:30 - 17:00				Inti Pineda	Luis Olguín
17:00 - 17:30	José Luis Hernández	Alejandro Kunold		Carlos Ruíz	Guillermo Chacón
17:30 - 18:00	COFFEE	COFFEE		COFFEE	COFFEE
Chair:	Eleuterio Castaño	José Luis Hernández		Marco Vinicio Vázquez	
18:00 - 18:30	Emerson Sadurni	Norberto Aquino		Salvador Herrera	L. García–Colín Medal Lecture by Claus Lämmerzahl
18:30 - 19:00	Antonio Méndez	Eleuterio Castaño		Dennis Boyer	
19:00 - 19:30	Gabriela Báez	Remigio Cabrera		L. Vicente Hinestroza	
19:30 - 20:30			Public Lecture by Luis Felipe Rodríguez		Closure and Honor Wine
20:30			Conference Dinner		

VI. SYMPOSIUM ON PLASMA PHYSICS

Program Committee:

- Guillermo Chacón-Acosta
  E–mail: gchacon@correo.cua.uam.mx
- Alfredo Sandoval-Villalbazo
  E–mail: alfredo.sandoval@ibero.mx
- Ana Laura García-Perciante
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A. Fundamentals of Plasma Physics

- Paul Romatschke
  Department of Physics,University of Colorado, USA
  E–mail: paul.romatschke@colorado.edu
  Title of the talk: The Good, the Bad and the Perfect Fluid
  Abstract: There are good fluids and not so good fluids, as anyone trying to empty an old jar of honey will attest. Good fluids are characterized by having a low viscosity coefficient. Experimentally one finds that viscosity can reach arbitrarily high values for different fluids. However, the converse is not true: it is hard to find fluids with a viscosity coefficient lower than that of water. Until the end of last century, one of the record holders for low viscosity values was fluid helium, but with the advent of heavy-ion colliders and ultracold atomic gas experiments this has changed. I will lead you on a search for the "perfect fluid", using results from fields as different as relativistic fluid dynamics, string theory, high energy nuclear physics and atomic physics along the way.
- James D. Callen
  Department of Engineering, University of Wisconsin, Madison.
  E–mail: callen@engr.wisc.edu
  Title of the talk: Effects of 3D magnetic perturbations on toroidal plasmas
  Abstract: *Background*: Small three-dimensional (3D) magnetic field perturbations have

many interesting and possibly useful effects on tokamak and quasi-symmetric stellarator plasmas [1]. Plasma transport equations that include these effects, most notably on diamagnetic-level toroidal plasma flows, have recently been developed [2]. *Types of 3D effects*: The 3D field perturbations and their effects on plasmas can be classified according to their toroidal mode number n [1]: low n (say 1 to 5) resonant (with field line pitch, $q = m/n$) and non-resonant fields, medium n (~ 20, due to toroidal field ripple), and high n (due to microturbulence). Low n non-resonant fields induce a neoclassical toroidal viscosity (NTV) that damps toroidal rotation throughout the plasma toward an offset rotation in the counter-current direction. Recent tokamak experiments have generally confirmed and exploited these predictions by applying external low n non-resonant magnetic perturbations. Medium n toroidal field ripple produces similar NTV effects plus possible ripple trapping effects and ion direct losses in the edge. A low n (e.g., $n = 1$) resonant field is mostly shielded by the toroidally rotating plasma at the resonant (rational) surface. If it is large enough it can stop plasma rotation at the rational surface, facilitate magnetic reconnection there and lead to a growing stationary magnetic island (locked mode), which often causes a plasma disruption. Externally applied 3D magnetic perturbations usually have many components. In the plasma their lowest n (e.g., $n = 1$) externally resonant components can be amplified by kink-type plasma responses, particularly at high plasma pressure (β). Low n plasma instabilities [e.g., resistive wall modes (RWMs), neoclassical tearing modes (NTMs)] cause additional 3D magnetic perturbations in tokamak plasmas. Tearing modes in their nonlinear (Rutherford) regime bifurcate the normally 2D axisymmetric topology and form magnetic islands. Finally, multiple resonant magnetic perturbations (RMPs) produce magnetic flutter [3] and can, if not shielded by plasma rotation effects, cause local magnetic stochasticity; both of these RMP effects can increase plasma transport in the edge of H-mode plasmas. *Applications*: These various effects of 3D fields can be used to modify directly the plasma toroidal rotation [and possibly transport via RMPs for controlling edge localized modes (ELMs)] and indirectly anomalous plasma transport. The present understanding and modeling of these various 3D magnetic field perturbation effects including for test blanket modules (TBMs) in ITER are summarized. Finally, implications of the present understanding and key open issues for developing a predictive capability of them for ITER are discussed.

*Research supported by U.S. DoE grants DE-FG02-86ER53218 and DE-FG02-92ER54139.

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Title of the talk: Transport barriers with and without shear flows in a magnetized Plasma

Abstract: Particle and energy transport in plasmas confined by a magnetic field is usually dominated by turbulent fluctuations rather than collisions, particularly in toroidal configurations of interest in nuclear fusion plasmas. The origin of the fluctuations is diverse but quite commonly it is associated to instabilities driven by the pressure gradient, which provides the free energy needed. These so called unstable drift waves can be stabilized in some region of the plasma by certain mechanisms in which case the fluctuation-driven transport is reduced in that region, creating what is known as a transport barrier. Here, I will discuss two mechanism that produce transport barriers. The first is associated with the presence of a sheared plasma flow that is present in a limited region of the plasma, which creates a zonal flow. The usual paradigm is that the sheared flow reduces the turbulence correlation length, leading to suppression of the fluctuation driven transport in the region of highest shear. In contrast, from the perspective of chaotic transport of plasma particles in the fluctuation fields, the transport barrier is formed in the region of zero shear and it can be destroyed when the fluctuation level is high enough. I will describe how this process arises and show that finite gyro-radius effects modify the dynamics. The second mechanism considers a method in which radio-frequency waves injected into the plasma can stabilize the drift waves and therefore the anomalous transport is reduced, creating a barrier. This process does not involve the presence of sheared flows and depends only on the effect of the RF wave field on the drift waves. The stabilizing effect in this case is due to the nonlinear ponderomotive force which acts in a way that offsets the pressure gradient destabilization. I will discuss the conditions required for this mechanism to be effective and

its importance in reaching a high confinement mode that is commonly obtained in toroidal magnetized plasmas.

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  Title of the talk: Two temperature relaxation process with a Fokker-Planck collision operator

  Abstract: The equilibration process of a binary mixture of gases with two different temperatures is revisited using a Fokker-Planck equation. The right hand side of the Boltzmann equation is approximated by a Fokker-Planck collision operator assuming different densities, with the more dense constituent being in thermodynamic equilibrium. The characteristic relaxation time is obtained for particular cases in terms of z_a/z_b, where $z_i = kT_i/m_ic^2$ is the relativistic parameter for each species. Both analytic as well as numerical results will be presented and compared with other works [1],[2],[3]. The corresponding extension to the relativistic case will also be discussed.

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  Title of the talk: Stochastization of magnetic field surfaces by means of external perturbing coils

  Abstract: Toroidal magnetic fields in devices such as tokamaks and stellerators can be described in terms of a Hamiltonian formulation, in which the magnetic poloidal magnetic flux plays the role of the Hamiltonian, while the toroidal angle coordinate plays the role of time, in analogy with the mechanical problem. Thus, it is natural to apply the techniques and results of Hamiltonian mechanics to the study of toroidal magnetic fields in fusion confinement devices, such as tokamaks and stellerators. To a certain extent, the success in designing a magnetic confinement device, rests in the capacity of producing a configuration,

such that there is a symmetry which allows the existence of closed and robust magnetic field surfaces. When such symmetry is broken, either by instabilities in the plasma, or by engineering defects in the design and construction of the system, the surfaces break up, leading to loss of confinement. It is the merit of the magnetic confinement fusion program that such good devices, with strong symmetry properties have been designed and operated successfully, through the past few years. On the other hand, it is necessary to include a system which allows the removal of impurities and ashes from a fusion reactor, generically known as a divertor. The most popular design is the so called poloidal divertor, which is based on the production of a separatrix, which bounds the closed magnetic field surfaces, but is surrounded by open external surfaces, which end up on a divertor plate. Such plate is subject to a high heat flux, and although it has been found as the best solution, is an expensive one. A different concept, would be to break up the external field surfaces in a controlled way, allowing the extraction of undesirable ions. This can be achieved by breaking up the symmetry by adding perturbing coils which produce resonances with rational magnetic surfaces. The purpose of this paper is to present a systematic study of the breaking of axisymmetric magnetic field surfaces when such symmetry is broken by perturbing coils surrounding the torus. A three dimensional code is used, which integrates via the magnetic field produced by toroidal and ploidal field coils in a tokamak, as well as the perturbing coils. Poincar maps are produced along the toroidal angle, showing the break-up of the magnetic surfaces, as well as the development of magnetic islands. The relevance of these results to space and astrophysical plasmas, which are three dimensional by nature will be discussed.

- Antonio M. Juárez
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  Title of the talk: Experimental studies of fundamental interactions of ions, neutrals and electromagnetic radiation
  Abstract: In this contribution I will present the recent studies and developments carried out in my research group involving the interaction of ions with electromagnetic radiation and neutral molecular species. In addition to this I will present recent experiments related to the measurement of the transport properties of these charged particles in neutral

gases. These research topics are currently being covered in my research group and the objective of my contribution will be to present an outlook of the experimental and theoretical work currently carried out in Mexico, in addition to presenting the challenges of ion-neutral-radiation interactions. In particular, I will mention our recent studies on the photoionization, using synchrotron radiation, of multiply charged ions by our group at the Advanced Light Source in the Lawrence Berkeley National Lab. In addition to this I will present our research work in charge exchange processes between ions and neutrals using accelerators in the 1-20 KeV range at the Instituto de Ciencias Físicas, UNAM. Finally, I will show our most recent experimental data on ion transport properties such as ion mobilities and ion-molecule reactions in an environment of weakly ionized plasmas and neutral buffers. This collective experimental efforts have a common goal: To provide fundamental information of the interaction of ion, electromagnetic radiation and neutrals that take place in different environments, from the interstellar media to that of the strong and weakly ionized plasmas relevant in fundamental and applied research in plasma physics.

B. Relativistic and Astrophysical Plasmas I

- Luis Felipe Rodríguez Jorge
  Centro de Radioastronomía y Astrofísica,UNAM, México.
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  Title of the talk: Feeding the Supermassive Black Hole at the Center of our Galaxy
  Abstract: Current astronomical research supports the existence of supermassive black holes (with masses of millions to billions of solar masses) at the center of most galaxies. In particular, the Milky Way (our galaxy) is known to host a black hole, Sgr A*, with four million times the mass of the Sun. We will summarize the history of supermassive black hole research and how the study of stellar orbits around Sgr A* has provided an accurate estimate of its mass. More recently, two topics have attracted the attention of astronomers. One is the possibility of imaging the shadow produced by Sgr A* on the radio emission in its surroundings. This research requires of observations at millimeter wavelengths of unprecedented angular resolution and will most probably involve the Mexican Large Millimeter Telescope of INAOE. The second topic is the discovery in 2012 that a cloud of gas is on

its way to Sgr A* and will reach its point of closest approach in the second half of 2013. This cloud may be disrupted by the tidal forces of the black hole and could be accreted over the next decade, increasing the luminosity of Sgr A* by a factor of 10.

- Håkan Andréasson
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  Title of the talk: On the existence, structure and stability of static and stationary solutions of the Einstein-Vlasov system

  Abstract: I will review the present status on the existence, structure and stability of static and stationary solutions of the Einstein-Vlasov system. Under the assumptions that a spherically symmetric static object has isotropic pressure and non-increasing energy density outwards, Buchdahl showed 1959 the bound $M/R < 4/9$, where M is the ADM mass and R the outer radius. Most static solutions of the Einstein-Vlasov system do not satisfy these assumptions. I will show that the bound $M/R < 4/9$ nevertheless holds and that it is sharp. An analogous bound in the charged case will also be given. The important question of stability of spherically symmetric static solutions is presently open but numerical results are available and these will be reviewed. A natural question is to go beyond spherical symmetry and consider axially symmetric solutions. I will discuss a recent result on the existence of rotating stationary solutions.

- Alejandro Raga
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  Title of the talk: The evolution of nebulae ionized by massive stars

  Abstract: Massive stars produce ultraviolet radiation that photoionizes the surrounding interstellar medium. These so-called "HII regions" (a few of them visible with the naked eye) are some of the most remarkable astrophysical objects that have been observed. Their evolution starts when a massive star forms within a dense molecular cloud, and its radiation photoionizes a dense, "compact HII region". As the star moves through the cloud and eventually reaches its edge, a "blister" HII region is formed. Eventually, when the star leaves the molecular cloud, it finally produces an extended, low density HII region. This evolution will be discussed, and the importance of the presence of a wind ejected from the

photoionizing source will be stressed.

- Alfredo Sandoval-Villalbazo
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  Title of the talk: The heat flux in special relativistic kinetic theory: Benedicks effect in simple relativistic fluids and its implications.
  Abstract: It is shown that a purely relativistic contribution to the heat flux in non-equilibrium simple relativistic fluids arises from kinetic theory through the use of Chapman-Enskog's method, and the consideration of an external electric field. The possible generalizations of this type of effect regarding gravitational fields are briefly explored.

- Roberto Sussman
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  Title of the talk: Testing proposals of "gravitational entropy" in General Relativity
  Abstract: Various proposals to define the notion of "gravitational entropy" have been suggested in the framework of General Relativity, from Penrose's initial idea of the "arrow of time", based on Weyl curvature scalars, to more elaborate proposals based on Information Theory and on a Super-Space phase description based in the Bell-Robinson tensor. We use the spherically symmetric LTB models, which provide a realistic toy model of cosmological inhomogeneities, to test the validity of these proposals by computing the associated properties of these proposals. The result is that the Information Theory proposal yields a positive entropy production and stable equilibrium states only for the Information Theory proposal. By considering the Schwarzschild-Kruskal limit of LTB models we prove that the Information Theory and Super Space proposals yield the well know Hawking-Beckenstein area entropy definition for spherically symmetric black holes.

C. Astrophysical Plasmas

- William Lee
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Title of the talk: Astrophysical accretion as a probe of extreme conditions in plasmas and a tool for mapping the Universe

Abstract: Under a variety of conditions in astrophysical sources, mass accretion onto a compact object takes place releasing vasts amounts of energy, and accounting for some of the most powerful sources observed. They are, at the same time, unique laboratories for the testing and validation of what we know about the properties of matter under extreme conditions of density and temperature, and intense gravitational fields. I will review scenarios relevant to the production of Supernovae and cosmological Gamma Ray Bursts, and what they can tell us not only about the events around them per se, but as tools in mapping the Universe on a large scale.

- Susana Lizano Soberón
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  Title of the talk: Gravitational Collapse and Disk Formation in Magnetized Cores

  Abstract: I discuss the effect of the magnetic field observed in molecular clouds on the gravitational collapse of low-mass dense cores to form a star plus disk system. In the early phases, the collapse of magnetized cores produces non-equilibrium pseudo-disks, and slow outflows that carry away angular momentum. Recent analytic work and numerical simulations show that a substantial level of magnetic field diffusion at high densities has to occur in order to form the observed rotationally supported disks. The newly formed accretion disks are threaded by the magnetic field dragged from the parent core during the gravitational collapse. These disks rotate with sub-Keplerian speeds because they are partially supported by magnetic tension against the gravity of the central star. Sub-Keplerian rotation makes it difficult to eject disk winds and can accelerate the process of planet migration. Magnetic fields also modify the Toomre criterion for gravitational instability via two opposing effects: on the one hand, magnetic tension and pressure increase the disk local stability, on the other hand, sub-Keplerian rotation makes the disk more unstable. In general, magnetized disks around young stars are more stable than their nonmagnetic counterparts; thus, they can be more massive and less prone to the formation of giant

planets by gravitational instability.

D. Relativistic and Astrophysical Plasmas II

- Esteban Calzetta
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  Title of the talk: Real relativistic fluids in heavy ion collisions

  Abstract: The theory of real relativistic fluids is in the rather unique situation that there is a natural relativistic extension of the nonrelativistic theory, but it is physically untenable [1]. On the other hand, mounting evidence that matter created in relativistic heavy ion collisions behaves as a relativistic fluid with small but finite viscosity has given the quest for an alternative a definite goal [2]. We shall present an approach to relativistic real fluids whereby the hydrodynamic regime is linked to the underlying kinetic theory through the entropy production variational principle [3,4]. We shall discuss the relationship of this approach to other existing ones and its application to the analysis of heavy ion collisions

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  Title of the talk: Aspects of heavy-ion collisions at the LHC

  Abstract: Stopping in heavy-ion collisions at high relativistic energies reached at RHIC and LHC is an initial state phenomenon that turns out to be well described in the color glass

condensate approach. Based on a proper theoretical description of RHIC heavy-ion data, baryon stopping predictions for Pb-Pb collisions at LHC energies are discussed [1].

Particle production at LHC through gluon-gluon and gluon-valence quark collisions, and the subsequent hadronization can be described in various microscopic and macroscopic models. Here I use a phenomenological three- sources approach that allows to precisely account for the charged-hadron pseudorapidity distributions measured by the ALICE collaboration in Pb-Pb collisions as function of centrality at the current c.m. energy of 2.76 TeV, and make predictions at the design energy of 5.52 TeV. The three-sources model also describes the asymmetric charged-particle distributions recently measured in proton-lead collisions at 5 TeV [2,3].

As a probe for the quark-gluon plasma that is likely created in heavy-ion collisions at RHIC and LHC energies, heavy quarkonia and in particular, the Upsilon meson as observed by CMS [4] have proven to be a very useful tool. Here it is suggested that the combined effect of gluon-induced dissociation, collisional damping, screening, and reduced feed-down explains [5] most of the suppression of Upsilon states that has been observed [4] in Pb-Pb relative to pp collisions at $\sqrt(s_N N) = 2.76$ TeV at the CERN LHC. The suppression is thus a clear, albeit indirect, indication for the presence of a Quark-Gluon Plasma.

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Title of the talk: Cloud and star formation in the magnetized interstellar medium

Abstract: I will review the basic physical processes in the interstellar medium (ISM) that affect the process of dense cloud formation, and of stars within the clouds. The ISM is

highly turbulent, even supersonically so in some cases; is subject to radiative heating and cooling, which combined cause the ISM to behave nearly isobarically; is partially or fully ionized, a condition which links it to the pervasive magnetic fields; and is self-gravitating, thus being unstable to gravitational collapse. I will discuss the interplay between these processes, and the emerging picture of the ISM's structure and the mechanisms through which starts form.

- Dominique Brun
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  Title of the talk: Entropy production in a simple fluid in the presence of external fields: the special relativistic case
  Abstract: Entropy production in a simple relativistic fluid is calculated through special relativistic kinetic theory, using a BGK-like approximation. It is shown that, besides a temperature gradient, there is also a contribution from a number density gradient, which is a purely relativistic effect. Moreover, the presence of an external field may cause strictly relativistic contributions to the entropy production that have not been identified before. Particularly a gravitational field, with linearized gravity and a Newtonian metric is used as an example, in order to relate the result with Tolman's law.

- Omar López Cruz
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  Title of the talk: The Physics of the Intracluster Medium
  Abstract: In this talk we review the physics of the intracluster medium (ICM), in particular we focus on the physics of the thermal Sunyaev-Zeldovich Effect (tSZE). We explore the correspondence among the parameters that can be derived from observations of the X-rays and the tSZE. In recent times the tSZE has been hailed as the most unbiased method to find galaxy cluster by mass. After reviewing the sources of contamination and the difficulties in the detection of tSZE, We argue that classical optical methods are as good as the tSZE for constraining Dark Energy scenarios. We finally comment on the possible tSZE observing programs using the recently opened Gran Telescopio Milimtrico Alfonso Serrano (GTM/LMT).

E. Relativistic Plasmas

- Gilberto Medeiros Kremer
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  Title of the talk: Relativistic Mixtures of Charged and Uncharged Particles

  Abstract: In this talk we analyze mixtures of relativistic gases within the framework of Boltzmann equation. Three systems are considered. The first one refers to a mixture of uncharged particles by using Grad's moment method, where the relativistic mixture is characterized by the moments of the distribution function: particle four-flows, energy-momentum tensors, and third-order moment tensors. The Navier-Stokes, Fourier and Fick laws are determined as well as the corresponding transport coefficients. In the second the relativistic laws of Ohm and Fourier are determined for binary mixtures of electrons with protons and electrons with photons subjected to external electromagnetic fields by using the Anderson and Witting model of the Boltzmann equation. The electrical and thermal conductivities are derived for non-degenerate and completely degenerate electrons. The third one consists in the derivation of Fick's law for a mixture of relativistic gases of non-disparate rest masses in a Schwarzschild metric from an extension of McCormac model equation applied to a relativistic truncated Grad's distribution function. It is shown that the diffusion coefficients depend on the gravitational potential.

- Peter Van
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  Title of the talk: Velocity and entropy production in relativistic dissipative hydrodynamics

  Abstract: In relativistic hydrodynamics there is a freedom in the choice of the velocity field. It is commonly accepted that it is connected to the motion of conserved charges. The common choices in case of a single component fluid are the so called Eckart frame, when the velocity is fixed to the motion particles, and the Landau-Lifshitz frame, when the velocity field is fixed to the flow of energy-momentum. These choices are properly justified in the absence of dissipation. Here we analyze this freedom in the presence of dissipation

and show that entropy production is independent of the choice of flow frame only if the entropy inequality is constrained by the complete energy-momentum balance. The local thermodynamic relations are modified accordingly.

- Jos Alejandro Ayala Mercado
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  Title of the talk: Head shock vs. Mach cone and the shape of the azimuthal correlations in heavy-ion collisions

  Abstract: We study the energy-momentum deposited by fast moving partons within a medium using linearized viscous hydrodynamics. The particle distribution produced is computed using the Cooper-Frye formalism. We show that for the conditions arising in heavy-ion collisions, energy momentum is preferentially deposited along the head shock of the fast moving partons. We also show that the double hump in the away-side of azimuthal correlations can be produced by two (instead of one) away-side partons that deposit their energy-momentum along their directions of motion. These partons are originated in the in-medium hard scattering in $2 \to 3$ processes. We compare the results of the analysis to azimuthal angular correlations from PHENIX and show that the calculation reproduces the data systematics of a decreasing away-side correlation when the momentum of the associated hadron becomes closer to the momentum of the leading hadron. This scenario seems to avoid the shortcomings of the Mach cone as the origin of the double-hump structure in the away-side.

- Valdemar Moratto
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  Title of the talk: Kinetic Theory of binary inert mixtures in special relativity

  Abstract: In order to assess the nature of the heat flux driven by density gradients in a simple relativistic fluid, we study a binary non reacting mixture under the perspective of kinetic theory in special relativity. We use the complete covariant Boltzmann equation and the Chapman-Enskog method up to first order in the gradients. In this way we obtain covariant expressions for the flux-force relations and suggest a particular structure so that

the compatibility between relativistic kinetic theory and linear irreversible thermodynamics is successfully achieved. The representation of the transport coefficients is clear and five new coefficients are incorporated. Consistency with Onsager's scheme in special relativity is discussed in view of the obtained results. We show an outline of the explicit calculation for such coefficients.

F. Schedule for the Symposium on Fundamentals of Plasma Physics

September	Monday 9	Tuesday 10	Wednesday 11	Thursday 12	Friday 13
09:30 - 10:00	Opening				
Chair:	Alfredo Macías	Leonardo Dagdug	Moisés Martínez	Guillermo Chacón	Darío Núñez
10:00 - 11:00	R. Ruffini	J. Percus	J. B. Pendry	J. Callen	H. Dittus
11:00 - 11:30	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Subject:	Fundamentals of Plasma Physics	Relativistic & Astrophysical Plasmas I	Astrophysical Plasmas	Relativistic & Astrophysical Plasmas II	Relativistic Plasmas
Chair:	A. Sandoval	A. L. García	G. Chacón	G. Chacón	A. L. García
11:30 - 12:30	P. Romatschke	L. F. Rodríguez	W. Lee	E. Calzetta	G. M. Kremer
12:30 - 13:30	J. Callen	H. Andréasson	S. Lizano	G. Wolschin	P. Van
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Chair:	A. Sandoval	A. L. García		A. L. García	A. Sandoval
16:00 - 17:00	J. Martinell	A. Raga	Visit	E. Vázquez	J. A. Ayala
17:00 - 17:30	A. Méndez	A. Sandoval	to the	D. Brun	V. Moratto
17:30 - 18:00	COFFEE	COFFEE	Anthropology	COFFEE	COFFEE
Chair:	G. Chacón	G. Chacón	Museum	A. Sandoval	Alfredo Macías
18:00 - 19:00	J. Herrera	R. Sussman		O. López-Cruz	L. García–Colín Medal Lecture
					by
19:00 - 19:30	A. M. Juárez				Claus Lämmerzahl
19:30 - 20:30			Public Lecture by Luis Felipe Rodríguez		Closure and Honor Wine
20:30			Conference Dinner		

VII. SPONSORS

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