CAM 2017

CANADIAN-AMERICAN-MEXICAN
Graduate Student Physics Conference 2017

Physicists of the Future:
Transcending Boundaries

SMF
Sociedad Mexicana de Física

APS physics

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August 17 - 19, 2017
Hyatt Regency Washington
On Capitol Hill
Washington, D.C.

CANADIAN-AMERICAN-MEXICAN
Graduate Student Physics Conference 2017

Physicists of the Future: Transcending Boundaries

Hyatt Regency Washington
On Capitol Hill
Washington, D.C.
August 17-19, 2017

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CAP Foundation (CAPF)
SNOLAB

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The Forum on Graduate Student Affairs

of the American Physical Society

One Physics Ellipse, College Park, Maryland 20740

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Dear CAM2017 Participants,

Welcome to Washington, D.C., and the CAM2017 conference! The Organizing Committee—with the help of staff members from APS, CAP and SMF and numerous volunteers—have worked to put together another great CAM conference. Continuing the CAM tradition, this conference provides graduate students with a unique opportunity to explore and enjoy physics across a variety of subfields and observe how physics is an integral part of our lives beyond the laboratory. In addition to many student talks, invited talks and poster sessions, there are also two panel discussion sessions. These discussion sessions, designed to explore our theme of "Physicists of the Future: Transcending Boundaries," will touch on many of the boundaries, both concrete and abstract, physics graduate students encounter. As graduate students, we are the future of physics, and our collaborations and co-operation will hopefully promote scientific exchange and strengthen ties throughout North America.
This year, we also welcome a delegation from Cuba! We are excited to have our colleagues from Cuba participate in this conference for the first time.

I would like to congratulate and thank my fellow committee members, staff members of APS, SMF and CAP, members of the Local Organizing Committee and volunteers. I would also like to thank the American Physical Society's Forum on Graduate Student Affairs (FGSA) Executive Committee and all the CAM2017 sponsors for their generous support and help organizing CAM2017.

As you attend the sessions, use this unique opportunity to ask the invited speakers and students questions, provide your feedback and get to know your fellow participants. I hope you enjoy the many opportunities to converse, collaborate and cooperate with your colleagues and peers.

Thank you,

K Freeman

Krista Freeman
Chair, CAM2017 Organizing Committee
Past Chair, APS Forum on Graduate Student Affairs
Department of Physics
Carnegie Mellon University
Pittsburgh, Pennsylvania 15213

Thursday, 17 August

8:00 - 9:00 — **Registration & Breakfast** (Congressional A)

9:00 - 9:30 — **Welcoming Remarks** (Capitol Room)

Dr. Kate P. Kirby, Chief Executive Officer, American Physical Society

Dr. Luis Felipe Rodríguez Jorge, Council Member and former President, Sociedad Mexicana de Física

Mr. Christopher Pugh, Councillor, Canadian Association of Physicists

9:30 - 10:50 — **Plenary Session 1: Nuclear, Particle, and Accelerator Physics** (Capitol Room)

Chair: Mr. Flavio Manuel Nava Maldonado, Universidad Autónoma de Zacatecas, México

"Studying the weak force with laser cooled francium atoms"
Dr. Eduardo Gómez García, Universidad Autónoma de San Luis Potosí, México

"Are we finished with the Higgs? What does the next 20 years hold in store?"
Prof. Melissa Franklin, Harvard University, USA

10:50 - 11:05 — **Coffee Break**

11:05 - 12:35 — **Parallel Sessions** (Student Speakers)

A. **Condensed Matter Theory** (Congressional B)
B. **Particle Physics** (Congressional CD)
C. **Life Sciences and Biophysics** (Capitol Room)

12:35 - 13:35 — **Lunch Break** (Congressional A)

13:35 - 14:55 — **Plenary Session 2: Astrophysics and Cosmology** (Capitol Room)

Chair: Mr. Christopher Pugh, University of Waterloo, Canada

"Studying the formation of planets around young stars"
Dr. Luis Felipe Rodríguez Jorge, Universidad Nacional Autónoma de México, México

"The physics of nearby galaxies"
Prof. Pauline Barmby, University of Western Ontario, Canada

14:55 - 15:10 **Coffee Break**

15:10 - 16:40 **Panel Discussion 1: "Transcending Boundaries: Geographical, Disciplinary & Career" (Capitol Room)**

Moderator: Mr. Joyprokash Chakrabartty, Institut national de la recherche scientifique (INRS), Canada

Speakers:
Dr. Crystal Bailey, American Physical Society, USA
Dr. Eduardo Gómez García, Universidad Autónoma de San Luis Potosí, México
Prof. Zoya Leonenko, University of Waterloo, Canada
Prof. María Sánchez Colina, Cuban Physical Society, Cuba

16:40 - 18:10 **Parallel Sessions (Student Speakers)**

D. **Condensed Matter (Congressional B)**
E. **Astrophysics (Congressional CD)**
F. **Life Sciences and Biophysics (Capitol Room)**

18:10 - 18:30 **Break**

18:30 - 20:00 **Welcome Reception (Thornton Room - 11th Floor)**

Remarks:
Dr. Amy K. Flatten, Director of International Affairs, APS

Dr. Krista Freeman, Chair, CAM2017 Organizing Committee, Past Chair, APS Forum on Graduate Student Affairs (FGSA)

Friday, 18 August

8:00 - 9:00 **Breakfast (Congressional A)**

9:00 - 10:20 **Plenary Session 3: Biophysics and Soft Matter (Capitol Room)**

Chair: Ms. Silvia Cortés-López, Benemérita Universidad Autónoma de Puebla, México

"Cluster formation, dynamical arrest and effective interactions in soft condensed matter"
Prof. Ramón Castañeda-Priego, Universidad de Guanajuato, México

"Nanoscale biophysics to study molecular mechanism of Alzheimer's disease: towards prevention and cure"
Prof. Zoya Leonenko, University of Waterloo, Canada

General Program

10:20 - 10:35	**Coffee Break**
10:35 - 12:05	**Parallel Sessions (Student Speakers)** **G. Condensed Matter, Fluids, and Complex Systems (Congressional B)** **H. Quantum Information and Gravitation (Congressional CD)**
12:05 - 13:05	**Lunch Break (Congressional A)**
13:05 - 14:15	**Panel Discussion 2: "Transcending Boundaries: Personal and Societal: Life as a Graduate Student in Canada, México, Cuba, and the United States" (Capitol Room)** **Moderator: Dr. Krista Freeman,** Carnegie Mellon University, USA **Speakers:** **Ms. Ana Avilez-Lopez**, Centro de investigación y Estudios Avanzados del I.P.N (CINVESTAV), México **Ms. Midhat Farooq,** University of Michigan, USA **Mr. Christopher Pugh,** University of Waterloo, Canada **Ms. Gretel Quintero Angulo,** Universidad de La Habana, Cuba
14:15 - 14:30	**Coffee Break (and poster set-up if space available)**
14:30 - 16:00	**Plenary Session 4: Condensed Matter & Nanotechnology (Capitol Room)** **Chair: Mr. Eduardo Javier Domínguez Vázquez,** Universidad de La Habana, Cuba **"Thermal behavior of semiconductor lasers"** **Prof. María Sánchez Colina,** Universidad de La Habana, Cuba President, Cuban Physical Society **"Correlated Electrons: The Dark Energy of Condensed Matter"** **Prof. Laura H. Greene,** Florida State University, USA President, American Physical Society
16:00 - 18:00	**Poster Session (Congressional A)**
18:30	***Meet in hotel lobby to walk to banquet venue and pass through security. Bring photo identification. Photo ID is required to enter the Rayburn Building.***
19:00	**Banquet Dinner** **Venue: Capitol Hill Rayburn House Office, Building Foyer** **Brief welcoming remarks by dignitaries of physics societies.**

General Program

Saturday, 19 August

8:00 - 9:00 **Breakfast (Congressional A)**

9:00 - 10:20 **Plenary Session 5: Earth, Energy, and Environment (Capitol Room)**

Chair: Mr. Lucas Fabian Hackl, The Pennsylvania State University, USA

"Changing Snow and Sea Ice: Observations and Models, Predictions and Consequences"
Prof. Paul Kushner, University of Toronto, Canada

"Resolved to be Unresolved"
Prof. William Dorland, University of Maryland, USA

10:20 - 10:35 **Coffee Break**

10:35 - 12:05 **Parallel Sessions (Student Speakers)**

I. Atomic, Molecular, and Optical Physics (Congressional B)
J. Earth, Energy, and Environment (Congressional CD)

12:05 - 13:05 **Closing Remarks (Capitol Room)**

Dr. Amy K. Flatten, Director of International Affairs, APS
Mr. Flavio Manuel Nava Maldonado, Student Representative, SMF
Mr. Christopher Pugh, Student Representative, CAP
Dr. Krista Freeman, Chair, CAM2017 Organizing Committee, Past Chair, FGSA

Thursday, 17 August

Session A: Condensed Matter Theory (Congressional B)

Chair: Mr. Étienne Lantagne-Hurtubise, Canada

11:05 - 11:20	A.1	**Thomas E. Baker (USA)** Categorization of effects and novel physics in superconducting-magnetic proximity systems
11:20 - 11:35	A.2	**Ransel Barzaga Guzmán (Cuba)** The contraction of terraces in the Au(100) surface: A DFT study
11:35 - 11:50	A.3	**Seyyedeh Azar Oliaei Motlagh (USA)** Ultrafast chiral electron dynamics in 3d topological insulator Bi_2Se_3
11:50 - 12:05	A.4	**Benjamin Santos (Canada)** Analysis on the effect of the electrostatic interaction in the coagulation of silicon nanoparticles in a Capacitively-Coupled RF argon-silane plasma
12:05 - 12:20	A.5	**Andrii Bozhko (USA)** Surface plasmon propagation in thin films with epsilon-near-zero transition layers at metal-dielectric interfaces
12:20 - 12:35	A.6	**Gretel Quintero Angulo (Cuba)** Condensation of neutral vector bosons with magnetic moment in a constant magnetic field

Session B: Particle Physics (Congressional CD)

Chair: Mr. Jesús Alberto Santos Morales, México

11:05 - 11:20	B.1	**Frank Jensen (USA)** Search for supersymmetry using boosted Higgs bosons and missing transverse momentum in proton-proton collisions at 13 TeV
11:20 - 11:35	B.2	**Francisco Ramírez-Sánchez (México)** Higgs boson production and decay at future e^+e^- linear colliders as a probe of the extended B-L model
11:35 - 11:50	B.3	**Cristian Baldenegro (USA)** Probing anomalous quartic gauge couplings at the Large Hadron Collider with proton tagging
11:50 - 12:05	B.4	**Jorge Luis Acosta Avalo (Cuba)** Chiral current generation in QED by longitudinal photons
12:05 - 12:20	B.5	**Joydeep Roy (USA)** Probing the chirality of leptoquark couplings in the light of $R_D^{(*)}$; $R_K^{(*)}$ puzzle
12:20 - 12:35	B.6	**Adam J. Mayer (Canada)** Geochemical measurement of the half-life of the double-beta decay of ^{96}Zr

Parallel Sessions

Session C: Life Sciences and Biophysics (Capitol Room)

Chair: Ms. Chelsea Liekhus-Schmaltz, USA

11:05 - 11:20	C.1	**Jonathan Liu (USA)** Strong Accumulation of DNA at a Heated Air-Water Interface
11:20 - 11:35	C.2	**Roberto Fabian Jr. (USA)** Design of novel magnetic tweezers and its use for studying DNA-compacting proteins
11:35 - 11:50	C.3	**Luis Felipe Ponce Alvarez (Cuba)** Quantitative Contribution of IL2Rγ to the Dynamic Formation of IL2-IL2R Complexes Modeling interaction of Interleukin 1 with its receptors
11:50 - 12:05	C.4	**Matt Steffler (Canada)** Impact of Prelab Videos on Laboratory Exercises in a Large Enrollment Introductory Life Sciences Physics Course
12:05 - 12:20	C.5	**Hari Sharma (USA)** Molecular Dynamics Study of Gold Nanoparticle Encapsulation into Mixed Lipid Nanodiscs
12:20 - 12:35	C.6	**Wyatt J. Davis (USA)** Polymer Crowding in Confined Polymer-Nanoparticle Mixtures

Session D: Condensed Matter (Congressional B)

Chair: Mr. Ransel Barzaga Guzmán, Cuba

16:40 - 16:55	D.1	**Shunashi G. Castillo-López (México)** Quantum infrared response of a nonlocal metal film
16:55 - 17:10	D.2	**Edilio Lázaro Lázaro (México)** A theoretical approach of the amorphous solidification in binary mixtures
17:10 - 17:25	D.3	**Adam Iaizzi (USA)** Magnetic field effects in a 2D quantum antiferromagnet
17:25 - 17:40	D.4	**Étienne Lantagne-Hurtubise (Canada)** A proposal for the realization of SYK physics in a topological superconductor
17:40 - 17:55	D.5	**Sobhit Singh (USA)** BiSb: A giant tunable Rashba semiconductor and quantum spin Hall insulator in two-dimensions
17:55 - 18:10	D.6	**Marzieh Kavand (USA)** Pulsed Ferromagnetic Resonance Driven Inverse Spin-Hall Effect in Organic and Inorganic Materials

Parallel Sessions

Session E: Astrophysics (Congressional CD)

Chair: Ms. Diana Alvear Terrero, Cuba

16:40 - 16:55	E.1	**Jonah Miller (Canada)** Discontinuous Galerkin Methods for Relativistic Astrophysics
16:55 - 17:10	E.2	**Jesús Alberto Santos Morales (México)** A supervised learning approach to estimate parameters of binary black holes from gravitational waves
17:10 - 17:25	E.3	**Diana Alvear Terrero (Cuba)** On slowly rotating magnetized white dwarfs
17:25 - 17:40	E.4	**Tiffany R. Lewis (USA)** A First-Principles Spectral Model for Blazar Jet Acceleration and Emission with Klein-Nishina Scattering of Multiple Broad Line Region Emission Lines
17:40 - 17:55	E.5	**Israel Martinez-Castellanos (USA)** HAWC first results highlights
17:55 - 18:10	E.6	**Karthik Ramanathan (USA)** First Direct-Detection Constraints on eV-Scale Hidden-Photon Dark Matter with the DAMIC experiment at SNOLAB

Session F: Life Sciences and Biophysics (Capitol Room)

Chair: Ms. Hermina C. Beica, York University, Canada

16:40 - 16:55	F.1	**Udaya Raj Dahal (USA)** Coil-helix transition of PEO upon nanoconfinement: Molecular dynamics simulations
16:55 - 17:10	F.2	**Zegnet Yimer Muhammed (USA)** Study on dioxygen binding to heme using SCAN functional
17:10 - 17:25	F.3	**Manuel Martínez-Jiménez (México)** Simulations of water-methanol mixtures with potentials fitted to reproduce the dielectric constants of pure liquids under ambient temperature and pressure
17:25 - 17:40	F.4	**Clay S. Miranda Contee (USA)** Application of Neural Network and Deep Learning Algorithms to Nodule Localization in Simulated and Real X-ray Radiographs
17:40 - 17:55	F.5	**Sudip Pandey (USA)** Magnetic, Structural, and Magnetocaloric Properties of Ni-Based Thermoseeds for Self-Controlled Hyperthermia
17:55 - 18:10	F.6	**Pejman Sanaei (USA)** Curvature and stress driven tissue growth in a tissue engineering scaffold pore

Parallel Sessions

Friday, 18 August

Session G: Condensed Matter, Fluids, and Complex Systems (Congressional B)

Chair: Ms. Yuliana Pineda Galvan, USA

10:35 - 10:50	**G.1**	**Pascal Nigge (Canada)** Evidence for superconductivity in Li-decorated monolayer graphene
10:50 - 11:05	**G.2**	**Min Prasad Khanal (USA)** Study of gamma-ray irradiation effects on AlGaN/GaN high electron mobility transistors
11:05 - 11:20	**G.3**	**Juan Carlos Sandoval Santana (México)** Detection of electron-nuclear spin oscillations of Ga paramagnetic centers in GaAsN: Master equation approach
11:20 - 11:35	**G.4**	**Eduardo Javier Domínguez Vázquez (Cuba)** Cluster Variational Method for disordered quantum systems
11:35 - 11:50	**G.5**	**Thomas Nevins (USA)** Dynamics of reaction front growth in unsteady flows
11:50 - 12:05	**G.6**	**Brian Weston (USA)** Physics-Based Numerical Simulations of the Selective Laser Melting Process in Metal 3D Printing

Session H: Quantum Information and Gravitation (Congressional CD)

Chair: Ms. Monica Salinas Ibañez, México

10:35 - 10:50	**H.1**	**Ana Avilez-Lopez (México)** Ultra-light scalar-field configurations as seeds of galactic haloes and their super massive black holes guests
10:50 - 11:05	**H.2**	**Saoussen Mbarek (Canada)** Thermodynamic Volume of Cosmological Solitons
11:05 - 11:20	**H.3**	**Christopher Pugh (Canada)** Airborne Demonstration of a Quantum Key Distribution Receiver Payload
11:20 - 11:35	**H.4**	**Lucas Hackl (USA)** Typical eigenstate entanglement of spinless fermions
11:35 - 11:50	**H.5**	**Aleksander Kubica (USA)** Three-dimensional color code thresholds via statistical-mechanical mapping
11:50 - 12:05	**H.6**	**Ramy Tannous (Canada)** Bright entangled photon source using PPLN for quantum communications

Parallel Sessions

Saturday, 19 August

Session I: Atomic, Molecular, and Optical Physics (Congressional B)
Chair: Mr. Thomas E. Baker, USA

10:35 - 10:50	I.1	**Hermina C. Beica (Canada)** Applications of auto-locked diode lasers
10:50 - 11:05	I.2	**Chelsea Liekhus-Schmaltz (USA)** Coherent control around a conical intersection using kinetic energy and the geometric phase
11:05 - 11:20	I.3	**Midhat Farooq (USA)** Application of Optical Mangetometry to a Particle Physics Experiment
11:20 - 11:35	I.4	**Hugh Podmore (Canada)** Compressive-sensing on-chip Fourier-transform spectrometers
11:35 - 11:50	I.5	**Silvia Cortés-López (México)** Nonlocal dielectric response of a high-temperature superconductor slab
11:50 - 12:05	I.6	**Sirak M. Mekonen (USA)** Studies of nonlinear optics in sorted single walled carbon nanotubes via z-scan technique

Session J: Earth, Energy, and Environment (Congressional CD)
Chair: Mr. Juan José González Armesto, Cuba

10:35 - 10:50	J.1	**William Elcock (Canada)** The Effect of Perovskite Cuboid Formation on J-V Hysteresis in Perovskite Solar Cells
10:50 - 11:05	J.2	**Yuliana Pineda Galvan (USA)** Spectroscopic studies of Ru-based water oxidation catalysts for artificial photosynthesis
11:05 - 11:20	J.3	**Joyprokash Chakrabartty (Canada)** An alternative approach to improve photovoltaic performance in multiferroic thin films
11:20 - 11:35	J.4	**Kristel Izquierdo (USA)** Constraining global mass anomalies using a Trans-dimensional Hierarchical Bayesian inversion algorithm
11:35 - 11:50	J.5	**Rahul Kashyap (USA)** Rogue Fluctuations in Fermi-Pasta-Ulam-Tsingou Systems

Poster Session

Friday, 18 August, 16:00 - 18:00 (Congressional A)

P.1 **Alberto Batista Tomás (Cuba)**
A fractal approach for development analysis of tropical clouds

P.2 **Carolina Bohórquez Martínez (México)**
Study of the electronic structure of undoped and Mn-doped ZnO and GaN

P.3 **Robert Caddy (USA)**
Time Series Photometry of the Symbiotic Binary NSV 11749

P.4 **Maria Magdalena Montsserrat Contreras Turrubiartes (México)**
Growth and Characterization of GaN and InN Thin Films grown by Atomic Layer Deposition

P.5 **Paul Masih Das (USA)**
Low-Dimensional Black Phosphorus Nanostructures

P.6 **Yesica Sonia Flores Meraz (México)**
Study of rare processes in extensions of the Standard Model with horizontal symmetry between families

P.7 **Carlos Alberto Gandarilla Pérez (Cuba)**
A Maxwell homogenization scheme for effective electro-elastic properties in nanocomposites

P.8 **Yalina García Puente (Cuba)**
Physical properties of $BiFeO_3$-based multiferroic ceramic systems

P.9 **Nancy García-Zúñiga (México)**
Dosimetry evaluation of intensity-modulated radiation therapy vs volumetric-modulated arc therapy for stereotactic corporal radiation therapy treatments

P.10: **Roberto Gómez Rosales (México)**
Synthesis of Hydroxyapatite from Organic Materials

P.11 **Juan José González Armesto (Cuba)**
Electron transport in quantum rings modulated by bidimensional quantum point contacts

P.12 **Manuel Alfredo Hernández Wolpez (Cuba)**
Estimation of grain boundary angles in Bi-2223 superconducting ceramics by means of transport measurements

P.13 **Amara Katabarwa (USA)**
Quantum Projective Simulation with Hamiltonian Evolution

P.14 **Erick Javier López-Sánchez (México)**
Cable equation for general geometry

P.15 **Mayra Jacaranda Sánchez González (México)**
Radiative corrections to the β-energy spectrum in kaons decays

P.16 **Nahid Shayesteh Moghaddam (USA)**
Electrical transport in NbTiN thin films

P.17 **Jacqueline Isamar Muro Ríos (México)**
A method based on classical entangled polarization modes and imaging to determine the Mueller matrix associated to transparent birefringent samples using a single incident beam

Poster Session

P.18 Flavio Manuel Nava Maldonado (México)
Nonlinear optical properties for asymmetric barrier heights in double zinc blende AlGaN/GaN quantum well

P.19 Edwin Rodríguez Horta (Cuba)
Application of computational mechanics to random Markov fields

P.20 Ramón Daniel Rodríguez Soto (México)
Gravitational waves detector prototype based on Michelson interferometer

P.21 Jose Guadalupe Rojas Briseño (México)
Exciton energies in asymmetric zinc blende InGaN/GaN quantum wells

P.22 Alma Rocío Sagaceta-Mejía (México)
Statistical foundations of Kaluza's magnetohydrodynamics: Thermoelectric and thermomagnetic effects

P.23 Monica Salinas Ibañez (México)
Electric dipole moments of charged leptons at one loop in the presence of massive neutrinos

P.24 Alan Ignacio Hernández Juárez (México)
Chromomagnetic and Chromoelectric Dipole Moments in the Fourth Generation Two-Higgs Doublet Model

P.25 Cristina Schlesier (USA)
Measuring Spin Precession in Muon g-2

P.26 Pablo Serrano-Alfaro (Cuba)
Determination of stacking ordering in disordered close packed structures from the pairwise correlation functions

P.27 Roberto Silva González (Cuba)
New insights of the Generalized Lifshits–Slezov–Wagner Distribution theory influenced by a second phase transformation

P.28 Kalisa Aneika Villafana (USA)
High-Spin Gamma-ray Spectroscopy in ^{179,180}W

P.29 Laura Olivia Villegas Olvera (México)
Formation and evolution of SuperMassive Black Holes

P.30 Pheona Williams (USA)
Temperature-dependent Raman Spectroscopy of Topological Insulators

P.31 Tiffany Nichols (USA)
Map Usage in the Site Selection of the Laser Interferometer Gravitational-Wave Observatory (LIGO) Large-Scale Interferometers

P.32 Homa Assadi (Canada)
The Optical Properties of Biological Tissue on the Presence of Microbubbles

P.33 Shaowei Li (USA)
Single Molecule Mechanochemistry: Controlling the Hydrogen Dissociation by Scanning Tunneling Microscope

P.34 Dena Monjazebi (Canada)
Feasibility of Diagnostic Interstitial Ex-Vivo Mammary Autofluorescence Microendoscopy

Thursday, 17 August

Plenary Session 1: Nuclear, Particle, and Accelerator Physics

Dr. Eduardo Gómez García, Universidad Autónoma de San Luis Potosí, México

"Studying the weak force with laser cooled francium atoms"

Abstract: Francium is an excellent candidate for the study of the weak force through Parity Non Conservation (PNC) measurements due to its simple electronic structure and its big nucleus. Our approach differs from other atomic PNC experiments in that we target multiple isotopes and we use laser cooled atoms, which benefit from compact sample volumes and coherent measurements. We are interested in both the nuclear spin dependent and independent parts of the weak interaction. The first one probes the weak force within the nucleus by the measurement of the anapole moment and the second one tests the electroweak sector of the standard model at very low energies. I will explain the details of both experiments and I will present recent measurements on the hyperfine anomaly and the isotope shift in a chain of francium isotopes. (Work supported by DOE, Fulbright, and NSF from USA, NSERC, NRC, and TRIUMF from Canada, and CONACYT from Mexico.)

Biographical Summary: Dr. Gómez's research interests are on precision measurements taking advantage of the recently developed techniques of laser manipulation of atoms. As part of the FrPNC collaboration, he uses francium atoms to study the weak force via Parity Non Conservation measurements. He also works with rubidium atoms to develop sensitive accelerometers. These sensors are very well suited to study the gravitational force.

Prof. Melissa Franklin, Harvard University, USA

"Are we finished with the Higgs? What does the next 20 years hold in store?"

Abstract: I will talk about what we have found when we have found the Higgs boson, what is left to understand and what bigger or better accelerators are on the horizon.

Biographical Summary: Dr. Franklin works with the ATLAS collaboration on the Large Hadron proton proton collider. She is currently working on an upgrade for the muon detector, and searching for supersymmetric top squarks, new particles which decay to two Higgs bosons and anomalous production of displaced vertices.

Plenary Session 2: Astrophysics and Cosmology

Dr. Luis Felipe Rodríguez Jorge, Universidad Nacional Autónoma de México, México

"Studying the formation of planets around young stars"

Abstract: The formation of new stars in space is a phenomenon that started being observed with different astronomical techniques since the 1950s. It was suspected that the formation of the star happened simultaneously with the formation of planets around it. However, the sensitivity and angular resolution of the telescopes was insufficient to test this hypothesis. It is only in the last two decades that it has been confirmed that young stars form surrounded of a flattened, rotating structure of gas and cosmic dust, called the protoplanetary disk, from where planets are forming. The telescopes now available, in particular the Atacama Large Millimeter Array, allow the imaging of these disks that show a diversity of morphologies suggesting the onset of planetary formation that we are only starting to understand.

Biographical Summary: Luis F. Rodriguez got his B.S. in Physics at the National University of Mexico (UNAM) and his Ph.D. in Astronomy at Harvard University. He studies the formation of stars and planets in the Milky Way using radio astronomical observations. He works at the Institute of Radio Astronomy and Astrophysics of UNAM in Morelia, Mexico.

Prof. Pauline Barmby, University of Western Ontario, Canada

"The physics of nearby galaxies"

Abstract: Galaxies are the places where stars are born, live, and die, recycling their newly-produced elements into the next generation of stars and planets. Many different physical processes are involved in this cycle: understanding their interplay in the interactions of the constituents of galaxies requires a combination of careful observations and detailed simulation. Combining observations at many different wavelengths of light constrains models of galaxy formation and evolution, allowing us to take apart and reconstruct the histories of these "island universes". This talk will discuss some new results in the observational study of nearby galaxies, with a particular focus on the Andromeda galaxy, the nearest large spiral.

Biographical Summary: Dr. Pauline Barmby received her PhD in Astronomy from Harvard in 2001 and spent the next 6 years working on NASA's Spitzer Space Telescope at the Smithsonian Astrophysical Observatory. She has been at Western since 2007 and is currently the acting dean of its Faculty of Science. Her research focuses on applying innovative statistical and computational techniques to multiwavelength observations of nearby galaxies.

Friday, 18 August

Plenary Session 3: Biophysics and Soft Matter

Prof. Ramón Castañeda-Priego, Universidad de Guanajuato, México

"Cluster formation, dynamical arrest and effective interactions in soft condensed matter"

Abstract: One major goal in soft condensed matter is identifying the physical mechanisms that lead to the formation of the main building blocks that are partially responsible for the birth of new equilibrium phases and arrested states of matter, for example, fluids of clusters, gels, glasses, among others. Contrary to the well-established thermodynamic criteria that allow us to determine the conditions where the equilibrium states of a many-body system can occur, there is no a general, consistent and unified definition to clearly identify those non- equilibrium states accessible to the system under consideration. Additionally, little is known about the effective interactions among macromolecules dispersed in a host medium close to a non-equilibrium thermodynamic state. Then, in this talk, we will briefly discuss the formation of clusters and its relationship with the extended law of corresponding states. Through Monte Carlo computer simulations of states identified in experiments, we show that dynamical arrest in adhesive hard-sphere dispersions is the result of rigidity percolation. Finally, based on the integral equations theory for simple liquids, we account for the effective forces among colloids under situations where the colloidal system is close to a thermodynamic instability or near to the boundary of gelation.

Biographical Summary: Dr. Castañeda-Priego has been a Full Time Professor in the Division of Sciences and Engineering at the University of Guanajuato, Mexico since 2004. In 2016, he received the National Award for Young Scientists in the area of Hard Science from the Mexican Academy of Sciences. His research interests are in thermodynamics, structural properties, transport phenomena, dynamical arrest, and self-assembly of many-body systems, as well as advanced numerical algorithms, parallel computer simulation methods, and experimental techniques for soft condensed matter physics.

Prof. Zoya Leonenko, University of Waterloo, Canada

"Nanoscale biophysics to study molecular mechanism of Alzheimer's disease: towards prevention and cure"

Abstract: Alzheimer's disease (AD) is a neurodegenerative disease characterized by dementia and memory loss for which no cure or prevention is available. Amyloid toxicity is a result of the non-specific interaction of toxic amyloid oligomers with the plasma membrane.

We use nanoscale biophysics approaches such as atomic force microscopy (AFM), Kelvin probe force microscopy (KPFM), molecular dynamics (MD) simulations and surface plasmon resonance (SPR) to study amyloid aggregation and interaction of amyloid beta (1-42) peptide with lipid membrane. With AFM-based atomic force spectroscopy (AFS), we measured the binging forces between two single amyloid peptide molecules. Using AFM imaging we showed that oligomer and fibril formation is affected by surfaces, presence of metals and inhibitors. We demonstrated that lipid membrane plays an active role in amyloid binding and toxicity. Effect of lipid composition, the presence of cholesterol and melatonin are discussed. We discovered that membrane cholesterol creates nanoscale electrostatic domains which induce preferential binding of amyloid peptide, while membrane melatonin reduces amyloid-membrane interactions, protecting the membrane from amyloid attack. Using AFS we tested a set of novel pseudo-peptide inhibitors (potential drug candidates) and showed that they effectively prevent amyloid-amyloid binding on a single molecule level, and work well in cellular models to prevent amyloid toxicity. These findings contribute to better understanding of the molecular mechanisms of Alzheimer's disease and aid to the developments of novel strategies for cure and prevention of AD.
References: 1. M.Robinson, B.Y.Lee, Z.Leonenko. AIMS Molecular Science, 2015, 2(3): 332-358. 2. E.Drolle, R.M.Gaikwad,

Z.Leonenko, *Biophysical Journal*, 2012, 103(4), L27-L29. 3. F.Hane, E.Drolle, R.Gaikwad, E.Faught, Z.Leonenko. 2011. *J. Alzheimer's Dis.* 26: 485-494. 4. E.Drolle, F.Hane, B.Lee, Z.Leonenko, *Journal of Drug Metabolism Reviews*, 2014, 46(2): 207-223. 5. E.Drolle, N. Kučerka, M.I.Hoopes, Y.Choi, J. Katsaras, M. Karttunen, Z.Leonenko, *Biochimica & Biophysica Acta: Biomembranes*, 2013, 1828 (9): 2247-2254. 6. F.T.Hane, S.J.Attwood, Z.Leonenko, *Soft Matter*, 2014, 10(1): 206-213. 7. F.T. Hane, B.Y. Lee, A.Petoyan, A.Rauk, Z.Leonenko, *Journal of Biosensors and Bioelectronics*, 2014, 54, 492–498.

Biographical Summary: Dr. Zoya Leonenko, Professor, Department of Physics and Astronomy, Department of Biology, Waterloo Institute for Nanotechnology, University of Waterloo; Vice President of the Biophysical Society of Canada. PhD in Chemical Physics, 1996, Novosibirsk, Russian Academy of Sciences. Dr. Leonenko is leading the Nanoscale Biophysics research group at the University of Waterloo. Current research interests include: biophysics of lipid membrane and lipid-protein interactions, the role of structural changes and physical properties of lipid template in controlling biological processes and diseases; biomedical nanotechnology and quantum biology. Current research projects are: molecular mechanism of Alzheimer's disease; antimicrobial peptide function; the structure and function of lung surfactant; drug and drug delivery systems development; novel nano-biosensing approaches; quantum effects in neuronal networks.

Plenary Session 4: Condensed Matter & Nanotechnology

Prof. María Sánchez Colina, Universidad de La Habana, Cuba

President, Cuban Physical Society

"Thermal behavior of semiconductor lasers"

Abstract: Most challenges faced in modern semiconductor devices are related to heating phenomena because the excess of heat generated during operation. This talk reviews the thermal behavior of semiconductor laser diodes. The problems related to the extraction of heat in GaInAs/AlInAs quantum cascade lasers (QCLs) are analyzed comparing three typical structures: the ridge-waveguide (RW), the buried heterostructure (BH) and the double channel (DC). The temperature distribution in the structures is obtained by solving the heat conduction equation with a two-dimensional anisotropic heat-flow model. The influence of design parameters such as the depth and width of the top contact as well as the material used as heat sink is carefully analyzed. Modeling results are compared with experimental reported data and an optimized structure is proposed. It was found that even when the buried structure offers the best performance compared with DC and RW it is more sensitive to changes in the contact geometry. Results show that in all structures the optimum ridge height is that in which it is etched a little into the substrate (~ 1 μm). An original method to obtain the thermal resistance is presented showing that, by measuring operational parameters in pulsed regime, like the threshold current, junction voltage and the electrical series resistance, it is possible to obtain the thermal resistance of unpackaged devices. Values of the thermal resistance obtained in this way agree very well with those obtained by conventional methods both for laser diodes and QCLs.

Biographical Summary: Dr. Sanchez's research focus is on thermal behavior of semiconductor devices such as lasers, light-emitting diodes (LEDs), and more recently, quantum-cascade lasers. She earned her Ph.D. in Physics from the University of Havana in 1996, and did training for six months with Nobel Prize winner Zhores Alferov at the Ioffe Institute in St. Petersburg. She has 30 years of experience teaching physics at the University of Havana, and has also taught graduate courses at the Autonomous University of Madrid, the Center for Research and Advanced Studies in Mexico City, and the Federal University of Minas Gerais in Brazil. She has been the Editor of the Cuban Journal of Physics and Dean of the Physics Faculty at the University of Havana. Presently, Dr. Sanchez is the president of the Cuban Physical Society.

Prof. Laura H. Greene, Florida State University, USA

President, American Physical Society

"Correlated Electrons: The Dark Energy of Condensed Matter"

Abstract: The nearly 80-year-old correlated electron problem remains largely unsolved; with one stunning success being BCS electron-phonon mediated "conventional" superconductivity. There are dozens of families of superconductors that are "unconventional" including the high-Tc cuprate, iron-based, and heavy fermion superconductors. Although these materials are disparate in many properties, some of their fundamental properties are strikingly similar, including their ubiquitous phase diagram in which the superconductivity emerges near a magnetic quantum phase transition, plus some intriguing, enigmatic electronic phases that arise in the non-superconducting states. A recent research direction is towards the fundamental understanding of these phases, in the anticipation to predictively design new higher-Tc, Jc, and more practical superconductors.

Biographical Summary: Laura H. Greene is the 2017 President of the APS, the Chief Scientist at the National MagLab, the Francis Eppes Professor of Physics at Florida State University and Associate Director of the Center for Emergent Superconductivity. Her research is in experimental condensed matter physics, investigating strongly correlated electron systems, including high-temperature superconductivity. Greene is a member of the National Academy of Sciences; and a Fellow of the American Academy of Arts and Sciences, the Institute of Physics (U.K.), the American Academy of Arts and Sciences, the AAAS, and the APS. Greene is co-chairing the NAS Decadal Survey for Materials Research and is on the AAAS Board of Directors. She has been a Guggenheim Fellow, received the E.O. Lawrence Award for Materials Research, the Maria Goeppert-Mayer Award, and the Bellcore Award of Excellence. She has co-authored over 200 publications and presented over 500 invited talks.

Saturday, 19 August

Plenary Session 5: Earth, Energy, and Environment

Prof. Paul Kushner, University of Toronto, Canada

"Changing Snow and Sea Ice: Observations and Models, Predictions and Consequences"

Abstract: The daily weather forecasts we count on for planning our work and leisure are just part of a suite of environmental prediction tools, based on first physical principles, that are available to predict climate over the coming weeks, the next season, the next decade, and the next century. What's the best way to develop these predictions, to test them, and ultimately to measure their utility? I'll approach these questions with a focus on the work of the Canadian Sea Ice and Snow Evolution Network (CanSISE, see www.CanSISE.ca), which is Canada's national research network devoted to predicting sea ice and snow on timescales from the seasonal to the centennial. Snow and sea ice research requires careful attention to observational uncertainty, the irreducible statistical uncertainty of chaotic natural variability, and uncertainty in our modelling tools. I will highlight how using our prediction toolkit in novel ways leads to insights into dynamical mechanisms explaining how Arctic sea ice loss might influence midlatitude weather and climate, and reflect on what the future might hold for snow and sea ice as a result of anthropogenic climate change.

Biographical Summary: Paul Kushner is a professor in the Department of Physics at the University of Toronto, the principal investigator of the Canadian Sea Ice and Snow Evolution Network (CanSISE), and the Vice President of the Canadian Meteorological and Oceanographic Society. He carries out research on climate and atmospheric dynamics, with a focus on the atmospheric general circulation and the role of snow and sea ice processes in influencing this circulation.

Prof. William Dorland, University of Maryland, USA

"Resolved to be Unresolved"

Abstract: Undergraduates learn early that the coordinate system one adopts for a problem can make all difference. However, many interesting problems remain difficult or insoluble in any coordinate system. We may change bases to make some parts of the problem easier, representing solutions in terms of Fourier series, for example, when we expect plane wave solutions. However, nonlinearity introduces convolutions, which can be expensive to evaluate. In computational physics, it is commonplace to work in multiple bases in the course of a calculation, solving each part of the problem using an optimal representation. The key is then to develop efficient ways to change bases together with clever ways to represent the interactions of resolved and unresolved parts of a solution in a given basis or coordinate system. I will present examples of these issues in terms of closures and algorithms for problems in plasma turbulence. Direct applications include modeling fluctuations in the solar wind and predicting the performance of fusion reactor designs.

Biographical Summary: William Dorland is a professor of physics and Distinguished Scholar-Teacher at the University of Maryland, a visiting professor of physics at the University of Oxford, and a visiting professor in nuclear engineering at MIT. He is an editor of the Journal of Plasma Physics, a fellow of the APS, and the 2009 winner of the E. O. Lawrence award. Dorland's papers have been cited more than 10,000 times. According to Google Scholar, 48 have been referenced at least 48 times. He graduated with a B.S. in physics (Phi Beta Kappa, Departmental Honors, and Summa cum Laude) from the University of Texas in 1988, and received his Ph.D. in Astrophysical Sciences from Princeton University in 1993. He also earned a Master's degree in Public Affairs from the Woodrow Wilson School at Princeton University in 1993 after completing a course of study focused on international science policy. He has served as chair of the APS Committee on the International Freedom of Scientists and of the APS/DPP Human Rights Committee. In 2000, he was recognized by the Council on International Educational Exchange for his work promoting study abroad for college students. Currently he is the chair of the NRC Plasma Science Committee.

Invited Speakers

Panel Discussions:

Thursday, 17 August

“Transcending Boundaries: Geographical, Disciplinary & Career”

Dr. Crystal Bailey
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Dr. Eduardo Gómez García
Instituto de Física,
Universidad Autónoma de San Luis Potosí,
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Prof. Zoya Leonenko
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Prof. María Sánchez Colina
President, Cuban Physical Society
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Friday, 18 August

“Transcending Boundaries: Personal and Societal: Life as a Graduate Student in Canada, México, Cuba, and the United States”

Ms. Ana Avilez-Lopez
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Invited Speakers

Ms. Midhat Farooq
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Mr. Christopher Pugh
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Ms. Gretel Quintero Angulo
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Session A: Condensed Matter Theory

Thursday, 17 August, 11:05 - 12:35 (Congressional B)

A.1 **Thomas E. Baker (USA)**

Categorization of effects and novel physics in superconducting-magnetic proximity systems

Competing ground states can introduce interesting results when mixed together. For example, singlet superconductivity (pairing electrons of opposite spin) and magnetism (aligning spins) are opposing states of matter. They compete when the two materials are placed in proximity. Understanding the effects when this occurs may lead to the next generation of spintronic computing devices. I review a Green's function formulation of the transport equations for superfluids and use it to survey many different types of magnetizations. This includes our proposal for a highly tunable exchange-spring. I demonstrate connections to classical physics and closed-form analytic solutions. From this, types of 0-ϖ Josephson current switching are classified according to symmetry. I also show that surprising effects appear from a cascade of quasi-particle transitions in rotating magnetizations, causing so-called "short-range" correlations to appear deep inside a magnetic material. We acknowledge funding from the National Science Foundation (DMR-1309341).

A.2 **Ransel Barzaga Guzmán (Cuba)**

The contraction of terraces in the Au(100) surface: A DFT study

The formation of gold islands and terraces on Au(100) surface is an a consequence reconstruction lifting, which is produced by the adsorption mechanism of sulfur atoms. We have employed dispersion-corrected density functional theory (DFT-D) under PBE approach to study sulphur atoms adsorption over three domains: island, terrace and vacancy. The evaluation of adsorption energy showed an order in stability of island > vacancy > terrace. The results demonstrated the tendency of sulphur atoms to adsorb in gold islands instead of vacancies and terraces. The sulphur atoms adsorbed over gold island provoked the horizontal expansion of Au(100) surface, as it was illustrated in a previous work [1]. This expansion produced a contraction of the Au-Au bond length of 0.06 Å in the near terrace to island. The effect of periodic boundary conditions (PBC) was neglected in the study of gold terrace contraction. As a consequence of contraction, the 4-fold coordination sites on the terrace showed a distorted geometry which made energetically unstable the sulphur adsorption. We predicted the formation of a sulphur pattern of six S atoms (S6) due to the shrinking of terrace. The model obtained for S6 pattern was in close agreement with previous experimental results. [1] C. E. Hernandez-Tamargo, R. Barzaga, H. Mikosch, J. A. Martínez, J. A. Herrera, M. H. Farías, M. P. Hernández, *Phys. Chem. Chem. Phys.* 18, 29987(2016).

A.3 **Seyyedeh Azar Oliaei Motlagh (USA)**

Ultrafast chiral electron dynamics in 3d topological insulator Bi_2Se_3

We theoretically study the interaction of an ultrafast laser pulse with an electron system at a surface of 3D topological insulator Bi_2Se_3. We consider the low energy effective electron Hamiltonian, which includes the cubic momentum hexagonal wrapping terms. In the presence of the ultrafast laser pulse, quantum electron dynamics is coherent, but highly irreversible. This irreversibility results in a finite conduction band population after the pulse ends (residual conduction band, (RCB), population). We find that under a linearly polarized pulse the RCB population distribution in the reciprocal space is anisotropic due to the hexagonal terms. The distribution of RCB population in the reciprocal space strongly depends on the polarization of the pulse. Moreover, for a circularly polarized light the response of the system, unlike graphene, depends on the chirality (helicity) of the incident pulse. This is due to the hexagonal wrapping terms which are responsible for breaking full rotational symmetry down to three-fold rotational symmetry.

A.4 **Benjamin Santos (Canada)**

Analysis on the effect of the electrostatic interaction in the coagulation of silicon nanoparticles in a Capacitively-Coupled RF argon-silane plasma

We propose the numerical study of the effects of the electrostatic interaction of nanometric sized particles of silicon in the free-molecular regime on the coagulation enhancement factor in a capacitively-coupled RF argon-silane plasma. Our simulations are based on the dust-plasma self-consistent models proposed model by the S. L. Girshick's group [*Plasma Chem Plasma Process* 27, 292 (2007)., L. Ravi and S. L. Girshick, *Phys. Rev. E* 79, 026408 (2009)., P. Agarwal and S. Girshick, *Plasma Sources Sci. Technol*. 21, 055023 (2012).] This model represents a challenge because of complexity: nanoparticles can accumulate charge, coagulate and grow while strongly coupled with the plasma. In analogy with aerosol physics, we describe the nanoparticle model using a General Dynamics Equation. In order to follow the evolution of nanoparticle size and charge distribution we must partition it in representative sizes and charges, for each point in the spatial domain. Thus, for each combination of charge and size we need to calculate a drift-diffusion equation. First we introduce 0D simulations which complement the argument of coagulation of silicon nanoparticles in low temperature plasmas. We found that taking into account the dielectric nature of the particles modifies its coagulation rate. Then we discuss the extension to 1D model. This approach could easily be applied to particles of different composition.

A.5 **Andrii Bozhko (USA)**

Surface plasmon propagation in thin films with epsilon-near-zero transition layers at metal-dielectric interfaces

The propagation of surface plasmons is usually studied assuming the metal-dielectric interface is ideally sharp, i.e. the dielectric function suffers a discontinuity jump. However, the actual transition inside the finite-width layer near the metal surface is smooth and therefore introduces a critical point where the dielectric function passes through zero. This singularity point leads to formal divergence of the electric component in a propagating wave which may be yet another reason of various predicted and observed enhancements in many plasmonic effects, and also gives rise to additional collisionless damping of surface plasmon even in dissipationless metal. Here we propose a novel integral eigenvalue approach to the problem of surface plasmon propagation along a metal-dielectric interface with finite-width transition layer of arbitrary shape, and we consider cases of both metallic semispace and thin film. We show that the problem is not Hermitian and theoretically calculate the damping of the surface plasmon, as well as the correction to its spectrum. We also show that in the case of a thin film in a dielectric environment one can manipulate the thickness of the transition layers and thus convert the ordinarily non-radiative long-range plasmonic mode into the radiative mode by applying external electric field.

A.6 **Gretel Quintero Angulo (Cuba)**

Condensation of neutral vector bosons with magnetic moment in a constant magnetic field

We study the thermodynamical properties of a neutral vector boson gas in a constant magnetic field starting from the spectrum obtained by Proca formalism. Bose Einstein Condensation (BEC) and magnetization are obtained, for the three and one dimensional cases, in the limit of low temperatures. In three dimensions the gas undergoes a phase transition to a usual BEC in which the critical temperature depends on the magnetic field. Therefore, the condensation is reached not only decreasing the temperature, but also by increasing the field. For the one dimensional gas a diffuse BEC appears. In both, one and three dimensions, the magnetization is a positive quantity and for densities under a critical value the gas can sustain its own magnetic field. The anisotropic pressures are also considered. The pressure exerted along the field is always positive, but the perpendicular pressure might be negative and the system turns out to be susceptible to suffer, under certain conditions, a transversal magnetic collapse. The above describe phenomenology is manifested for magnetic fields and densities in the order of those typical of compacts objects. In this regard, a brief discussion of astrophysical implications is presented.

Parallel Session Abstracts

Session B: Particle Physics

Thursday, 17 August, 11:05 - 12:35 (Congressional CD)

B.1 **Frank Jensen (USA)**

Search for supersymmetry using boosted Higgs bosons and missing transverse momentum in proton-proton collisions at 13 TeV

CMS results at 8 and 13 TeV have placed bounds on gluino, squark, and electroweakino production in supersymmetric extensions to the Standard Model. The current sensitivity in some regions of phase space motivates more targeted searches. Depending on the mass spectra of the new particles, these models predict boosted objects, such as high p_T vector bosons, in association with missing energy from sparticles escaping detection. A new analysis strategy using jet substructure techniques is applied in hopes of enhancing sensitivity to models where a boosted object can be contained in a single large jet. We will describe an analysis looking for evidence of supersymmetry in events with missing energy and boosted Higgs bosons (decaying to b-quarks) in the final state. We will compare our sensitivity to other analyses and describe the current limits on these production scenarios.

B.2 **Francisco Ramírez-Sánchez (México)**

Higgs boson production and decay at future e^+e^- linear colliders as a probe of the extended B-L model

We study the phenomenology of the light and heavy Higgs boson production and decay in the context of a $U(1)_{B-L}$ (Baryon minus Lepton) extension of the Standard Model with an additional Z' (heavy) boson to be a Higgs factory at high energy and high luminosity linear electron positron colliders, such as the ILC and CLIC, through the Higgs-Strahlung processes $e^+e^- \rightarrow (Z, Z') \rightarrow Zh$ and $e^+e^- \rightarrow (Z, Z') \rightarrow ZH$, including both, the resonant and nonresonant effects. We evaluate the total cross sections of Zh, and ZH and calculate the total number of events for integrated luminosities of £= 500 - 3000 fb −1 and center of mass energies between 500 and 3000 GeV. We found that the total number of expected events can reach 10^6 and 10^5 respectively, which is a very optimistic scenario, allowing us to perform precision measurements of both Higgs Bosons as well as for the Z' heavy boson in future high energy and high luminosity e^+e^- colliders experiments.

B.3 **Cristian Baldenegro (USA)**

Probing anomalous quartic gauge couplings at the Large Hadron Collider with proton tagging

The primary goal of the Large Hadron Collider is to find signatures of physics Beyond the Standard Model of particle physics. One way to do this is in the precision sector; looking for small deviations from the Standard Model predictions. In this presentation, we address the discovery potential of New Physics in the exclusive channel $pp \rightarrow p\,X\,p$, where p stands for proton and X is a central massive system. The study relies on the general purpose detectors (CMS, ATLAS) at the LHC and the forward proton detector stations (TOTEM, AFP), located at about ~ 210 m w.r.t. the interaction point. As a proof of concept, we discuss the exclusive diphoton production at high invariant mass $m_{\gamma\gamma}$. We describe the event selection for the SM and New Physics diphoton events and quote sensitivities on the anomalous $\gamma\gamma\gamma\gamma$ coupling for an integrated luminosity of 300 fb^{-1} at the center-of-mass energy of 14 TeV.

B.4 **Jorge Luis Acosta Avalo (Cuba)**

Chiral current generation in QED by longitudinal photons

We report the generation of a pseudovector electric current having imbalanced chirality in an electron-positron strongly magnetized gas in QED. It propagates along the external applied magnetic field **B** as a chiral magnetic effect in QED. It is triggered by a perturbative electric field parallel to **B**, associated to a pseudovector longitudinal mode propagating along **B**. An electromagnetic chemical potential was introduced, but our results remain valid even when it vanishes. A nonzero fermion mass was assumed, which is usually considered vanishing in the literature. In the quantum field theory formalism at finite temperature and density, an anomaly relation for the axial current was found for a medium of massive fermions. It bears some analogy to the Adler-Bell-Jackiw anomaly. From the expression for the chiral current in terms of the photon self-energy tensor in a medium, it is obtained that electrons and positrons scattered by longitudinal photons (inside the light cone) contribute to the chiral current, as well as the to pair creation due to longitudinal photons (out of light cone). In the static limit, an electric pseudovector current is obtained in the lowest Landau level. We also discuss about the introduction of a chiral chemical potential in the quantum field theory formalism at finite temperature and density.

B.5 **Joydeep Roy (USA)**

Probing the chirality of leptoquark couplings in the light of $R_D^{(*)}$; $R_K^{(*)}$ puzzle

Anomalies in recent LHCb and Babar measurements of $R_D^{(*)}$, and $R_K^{(*)}$ in *B* decays may indicate the new physics beyond the Standard Model (SM). The leptoquarks (LQ) that couple to the 3rd generation quarks and leptons have been proposed as a viable new physics (NP) explanation. Such left-handed LQs can couple to both bottom and top quarks. Since top particles decay before the hadronization, it is possible to reconstruct chirality of boosted top quarks and consequently the chirality of top coupling to the LQs. We perform analysis on the top quark's chirality in the pair-production channel of the LQ, which can be 100% left-handed in comparison to unpolarized $t\bar{t}$ SM background. We study the prospects of distinguishing the chirality of a potential LQ signal for the high luminosity run of the LHC.

B.6 **Adam J. Mayer (Canada)**

Geochemical measurement of the half-life of the double-beta decay of ^{96}Zr

Double-beta decay measurements are a class of nuclear studies with the objective of detecting the neutrinoless decay variants. ^{96}Zr is of interest as a ββ decay candidate as it has one of the shortest half-lives and largest Q-values. A geochemical measurement of its ββ decay half-life was previously performed by measuring an isotopic anomaly of the ^{96}Mo daughter in ancient zircons. This measurement yielded a value of 0.9(3)x10^{19} a. Recently, the NEMO collaboration measured the half-life by a direct count rate measurement to be 2.4(3)x10^{19} a, twice as long as the geochemical measurement. We are studying this discrepancy through a series of experiments combining nuclear physics and geochemical techniques. We are measuring the amount of daughter product of the ββ decay of $^{96}Zr \rightarrow {}^{96}Mo$ in ancient zircons ($ZrSiO_4$) with ages from 500 Ma to 2.5 Ga. The zircons are suitable for this investigation due to their high Zr and low Mo contents making it possible to detect the small amount of accumulated decay product. To measure the ^{96}Mo excess, Mo must be fully separated from Zr as the mass spectrometer cannot resolve ^{96}Mo from ^{96}Zr. I will present advancements in the separation of molybdenum from $ZrSiO_4$ using Eichrom TEVA ion exchange resin. Further, I will present improvements to how the isotopic composition of Mo is measured using the Neptune MC-ICPMS. These advancements have enabled us to produce the first measurements of Mo isotope composition from 1 Ga and 2.5 Ga zircons using ICPMS.

Session C: Life Sciences and Biophysics

Thursday, 17 August, 11:05 - 12:35 (Capitol Room)

C.1 **Jonathan Liu (USA)**

Strong Accumulation of DNA at a Heated Air-Water Interface

Temperature gradients provide an energy source for many nonequilibrium phenomena, from fluid convection to molecular thermophoresis. We investigate microfluidic dynamics at an air-water interface that is subjected to a temperature gradient. We show that DNA is trapped from bulk solution and accumulated near the contact line of the interface, reaching concentrations of up to a 4000-fold increase. The accumulation happens rapidly – on the order of minutes – and exhibits a temperature dependence. We rationalize the findings with a simulation and conclude that the accumulation is the combined result of capillary flow, thermophoresis, and continuous evaporation-condensation cycles. At a scale of tens of microns, the above effects counteract the prominent Marangoni flow. The robust accumulation mechanism has broad implications, especially for studies on the origins of life. The findings complement previously discovered accumulation mechanisms from thermal convection and thermophoresis in bulk water.

C.2 **Roberto Fabian Jr. (USA)**

Design of novel magnetic tweezers and its use for studying DNA-compacting proteins

DNA inside cells takes part in numerous genetic processes which involve interactions between DNA and a variety of proteins. We developed an instrument called a horizontal magnetic tweezers that enables us to analyze these processes at the single molecule level. Our tweezers applies tiny forces to individual, isolated DNA molecules, which have two 2.8 μm beads attached to them, one on each end. The DNA-bead constructs are introduced into a custom-made sample cell under physiological buffer conditions. One of the two superparamagnetic beads is immobilized on a glass surface while the other bead is suspended near a small bar magnet. Different forces can be generated by changing the bead- magnet distance. For each force, we measure the DNA extension. These measurements may be performed with or without proteins, and by comparing the data in these two cases we can infer detailed information on the mechanics of protein-DNA interactions. We describe the tweezers in detail and present data validating its performance. We show that the tweezers complemented with image processing techniques can reliably measure changes in the DNA's extension suitable for studying the binding of proteins. We conclude with a discussion of our experiments on the binding mechanism of the protein mIHF, a protein that may play an important role in the infection pathway of tuberculosis.

C.3 **Luis Felipe Ponce Alvarez (Cuba)**

Quantitative Contribution of IL2Rγ to the Dynamic Formation of IL2-IL2R Complexes Modeling interaction of Interleukin 1 with its receptors

Interleukin 1 (IL1) is a mayor inflammatory cytokine that is related with many autoimmune diseases like rheumatoid arthritis and gout, and also is involved in the development of several kind of cancers like colon and lung cancers. IL1 system is composed by two agonist and one antagonist ligand which are IL1α, IL1β and IL1 receptor antagonist (IL1RA) and three membrane receptors IL1R type I (IL1RI), IL1R type II (IL1RII) and IL1R accessory chain protein (IL1RAcP). The IL1 signaling occurs when an agonist ligand interacts simultaneously with the IL1RI and IL1RAcP. We developed a model for the interaction of IL1 with the cells expressing IL1Rs and calibrate it with available experimental data of IL1α and IL1β binding to different cells. The model predicts that IL1RI and IL1RAcP but not IL1RII control both the sensibility and the signaling capacity of the cells to interact with IL1. We extended the model to study the capacity of the soluble IL1Rs in inhibit IL1 signaling. We obtain that the soluble form of IL1RI (sIL1RI) is the best strategy for blocking IL1α while sIL1RII is the best strategy to block IL1β. Moreover, the sIL1RA is the only strategy that is specific for cells with lower expression of IL1RAcP. Moreover, sIL1RI is the only strategy that have specificity for those scenarios with high concentration of sIL1RAcP and low concentration of IL1RA. This predictions can be used to infer the possible effect of the use of sIL1 inhibitors in clinic in different IL1R diseases.

C.4 **Matt Steffler (Canada)**

Impact of Prelab Videos on Laboratory Exercises in a Large Enrollment Introductory Life Sciences Physics Course

We discuss our implementation of targeted prelab videos designed for laboratory exercises in a large enrollment (900 student) introductory physics for the life sciences course. Our goal was to create preparatory videos that helped students have a better appreciation of the role of labs, strengthen conceptual understanding, and reduce time on task. Students were asked to take part in a survey about their experiences with the videos and the labs. Such factors as time to complete labs, impressions on lab manageability and insight gained, and overall comments were gathered and analyzed. We found that 45 - 55% of students completed the prelab videos on a regular basis, which is much lower than anticipated. When time on task for individual labs was compared, it was found to have increased rather than decreased for the majority of the labs. We will discuss in the talk the implications of these results.

C.5 **Hari Sharma (USA)**

Molecular Dynamics Study of Gold Nanoparticle Encapsulation into Mixed Lipid Nanodiscs

Gold nanoparticles (AuNPs) have attracted growing attention for a variety of technological applications. AuNPs in combination with lipid nanocarriers are an attractive platform for biomedical applications ranging from imaging to drug/gene delivery agents. Using coarse grained molecular dynamics simulation with the MARTINI force field, we show that hydrophobically modified 1 nm AuNPs spontaneously enter mixed lipid nanodiscs composed of dipalmitoylphosphatidylcholine (DPPC) and dihexanoylphosphatidylcholine (DHPC) from the rim. This leads to the formation of ring-like structures along the nanodisc circumference. Upon a temperature increase the order parameter of lipid tails decreases resulting in a spontaneous transition of nanodiscs into vesicles with embedded AuNP string. Alternatively an open "round vase" structure with a ring of AuNPs along the rim can be formed. The effect of the length of hydrophobic alkane tether (C_8, C_{12} and C_{16}) grafted to the gold surface on the stability of lipid nanodisc and clustering of encapsulated AuNPs will be discussed and compared with experimental and computer simulation data.

C.6 **Wyatt J. Davis (USA)**

Polymer Crowding in Confined Polymer-Nanoparticle Mixtures

Crowding can influence the conformations and thus functionality of macromolecules in quasi-two-dimensional environments, such as DNA or proteins confined to a cell membrane. We explore such crowding within a model of polymers as penetrable ellipses, whose shapes are governed by the statistics of a 2D random walk. The principal radii of the polymers fluctuate according to probability distributions of the eigenvalues of the gyration tensor. Within this coarse-grained model, we perform Monte Carlo simulations of mixtures of polymers and hard nanodisks, including trial changes in polymer conformation (shape and orientation). Penetration of polymers by nanodisks is incorporated with a free energy cost predicted by polymer field theory. Over ranges of size ratio and nanodisk density, we analyze the influence of crowding on polymer shape by computing eigenvalue distributions, mean radius of gyration, and mean asphericity of the polymer. We compare results with predictions of free-volume theory and with corresponding results in three dimensions*. Our approach may help to interpret recent (and motivate future) experimental studies of biopolymers interacting with cell membranes, with relevance for drug delivery and gene therapy.

*W. K. Lim and A. R. Denton, *J. Chem. Phys*. (2016).

Session D: Condensed Matter

Thursday, 17 August, 16:40 - 18:10 (Congressional B)

D.1 **Shunashi G. Castillo-López (México)**

Quantum infrared response of a nonlocal metal film

The spatial dispersion effects on the interaction of a flat metallic film with infrared electromagnetic radiation have been studied within the Kubo linear approach for calculating the quantum current density of conduction electrons. It has been shown that the results are qualitatively different from those obtained in the model of the Boltzmann kinetic equation. In particular, at sufficiently small thickness values of the nonlocal metallic film, the infrared absorption exhibits sharp resonances in the frequency interval where the metal spatial dispersion is strong, whereas the Boltzmann kinetic approach predicts very smooth absorption oscillations. The absorption resonances result from the quantization of the electron wave vector inside the metal film. The number of resonances increases with the film thickness and, eventually, they coalesce with each other, going over into the semi-classical results of the kinetic approach.

D.2 **Edilio Lázaro Lázaro (México)**

A theoretical approach of the amorphous solidification in binary mixtures

Understanding the amorphous solidification requires the comprehension of the nature of the crossover from the ergodic (or equilibrium) regime, in which the stationary properties of the system have no history dependence, to the mysterious transition region, where the measured properties are non-stationary and depend on the protocol of preparation. In binary mixtures of spherical particles this complex dynamical behavior offers a rich variety of dynamically arrested states, ranging from gels, mixed states and distinct types of glasses which has been the subject of numerous and extensive investigations and are far from being completely understood. With this aim we present a non-equilibrium theoretical approach of the amorphous solidification able to describe the fingerprints of this phenomenology once that the preparation protocol is given.

D.3 **Adam Iaizzi (USA)**

Magnetic field effects in a 2D quantum antiferromagnet

We present a large-scale numerical study of a two-dimensional quantum antiferromagnet (AFM) known as the J-Q model using the stochastic series expansion quantum Monte Carlo method augmented with quantum replica exchange. The J-Q model is composed of the standard AFM Heisenberg exchange (J) with an additional four-spin interaction (Q). In the zero-field case, this four-spin interaction drives a transition from a Néel AFM to a dimerized state (a valence-bond solid or VBS) [1]. At this phase boundary, the elementary excitations are believed to be spinons (S=1/2 bosons) [1]. In the present work, we study this model in the presence of an external magnetic field. Near the Néel-VBS phase transition, the magnetic field produces a Bose-Einstein condensate of spinons, which should produce a linear contribution to the temperature dependence of the specific heat [2], which we indeed observe. We also study the saturation transition at high magnetic field, where we observe magnetization jumps to saturation above a critical coupling ratio Q/J, which we determine exactly. These jumps are an example of metamagnetism, a type of first-order quantum phase transition. [1] H. Shao, W. Guo, and A.W. Sandvik, Science 352, 213 (2016), [2] H.D. Scammell and O.P. Sushkov, Phys. Rev. Lett. 114, 055702 (2015)

D.4 **Étienne Lantagne-Hurtubise (Canada)**

A proposal for the realization of SYK physics in a topological superconductor

It is still unclear if Majorana particles, which are their own antiparticles, are realized as fundamental building blocks of nature. However, a vast theoretical and experimental effort has demonstrated their existence in a class of condensed-matter systems dubbed topological superconductors. Recently, a surprising connection was uncovered by Kitaev between a quantum mechanical model of randomly-interacting Majorana particles (the SYK model) and the physics of black holes in AdS_2 spacetime. In this talk, I will describe a proposal to physically realize the SYK model in a topological (Fu-Kane) superconductor in the presence of random disorder. Furthermore, I will argue that the interplay of interactions and random disorder in this system may give rise to a larger family of non-Fermi liquids with tunable scaling exponents.

D.5 **Sobhit Singh (USA)**

BiSb: A giant tunable Rashba semiconductor and quantum spin Hall insulator in two-dimensions

The search for novel two-dimensional giant Rashba semiconductors and quantum spin Hall insulators is vital in the development of the forthcoming nanospintronic technology. By means of the first-principles calculations, we investigate the electronic and vibrational properties of BiSb in 2D. The phonon, room temperature molecular dynamics and elastic constant calculations confirm the dynamical and mechanical stability of the BiSb monolayer at 0 K and at room temperature. We find that BiSb monolayer is a direct bandgap semiconductor with the presence of light two-dimensional electron gas (2DEG) near Fermi-level. Inclusion of spin-orbit coupling (SOC) yields a giant Rashba spin-splitting of 2DEG that can be significantly controlled by an external electric field and biaxial strain. The strength of the Rashba parameter (2.3 eVÅ) is amongst the largest yet known 2D Rashba semiconductors. The presence of the giant Rashba spin-splitting together with a large electronic bandgap of 1.6 eV makes this system of peculiar interest for optoelectronics applications. The observed Rashba effect in BiSb monolayer is quite robust even in the presence of the lattice defects, vacancies, and contact with a substrate material. Furthermore, we demonstrate that a novel quantum spin Hall insulating phase can be realized by stacking two BiSb monolayers in inverted Rashba ordering, i.e. BiSb-SbBi, and thus making this system of special interest for technological applications.

D.6 **Marzieh Kavand (USA)**

Pulsed Ferromagnetic Resonance Driven Inverse Spin-Hall Effect in Organic and Inorganic Materials

The spin-orbit coupling (SOC) strength and the spin diffusion length are crucial parameters for the applicability of a material for spintronics and measuring them accurately is therefore a crucial prerequisite for progress within this field. We have recently made progress on such measurement techniques by demonstration of pulsed inverse spin-Hall effect (ISHE) experiments for which we employed a pulsed ferromagnetic resonance (FMR) spin-pumping scheme in order to inject a pure spin current from a ferromagnetic (FM) substrate into organic semiconductor (OSEC) layers. When the FM is in resonance with pulsed microwave excitation, a strong, pure (that means charge free) spin-current is formed in the OSEC, which circumvents the impedance mismatch between the FM layer and the organic film. Because of the weak SOC in most OSECs, the inverse spin Hall effect (ISHE) that results from the spin pumping scheme is very subtle; yet with pulsed, high microwave power excitation of the FMR, strong p-ISHE signals can be measured, while, by choice of low duty cycles, measurements artifacts due to heating and other electromagnetic effects are minimized at the same time [1,2]. As the magnitude of the ISHE scales linearly with the Pointing flux that drives FMR, quantitative ISHE measurements require precise control of the FMR driving field amplitude B1. This is achieved by monitoring the Rabi nutation of paramagnetic spin-probes in proximity of the device on which the ISHE is measured [3].
References: 1. K. Ando, et al., *J. Appl. Phys*. 109, 103913 (2011). 2. D. Sun et al., *Nat. Mater.* 6418, (2016). 3. M. Kavand et al., *Phys. Rev.* B 95, 161406 (2017).

Session E: Astrophysics

Thursday, 17 August, 16:40 - 18:10 (Congressional CD)

E.1 **Jonah Miller (Canada)**

Discontinuous Galerkin Methods for Relativistic Astrophysics

We are entering the era of gravitational astronomy. The recent direct detection of the gravitational waves emitted by the in-spiral and merger of two black holes marks the beginning of an era where we will use gravitational waves in combination with electromagnetic and astroparticle signatures to extract information about astrophysical objects. Numerical relativity, the field of solving Einstein's equations of general relativity on a computer, has played and will continue to play a fundamental role in the detection of gravitational waves and the extraction of physics information from detection. In this talk, I briefly introduce numerical relativity and discuss my work on discontinuous Galerkin finite element methods, which I believe offer a mathematically beautiful and computationally efficient way to solve many partial differential equations, including those found in computational astrophysics.

E.2 **Jesús Alberto Santos Morales (México)**

A supervised learning approach to estimate parameters of binary black holes from gravitational waves

In sixteen months the LIGO (Laser Interferometer Gravitational-wave Observatory) has reported three direct detections of gravitational waves (GW) from binary systems which suggests that the merger of two black holes is more frequent than we expected. Detection of GWs consists on measuring and identifying small deformations of the space-time (i.e., strain) that are produced by astronomical massive objects. The inverse problem in GWs consists on identify the astrophysical source parameters, e.g., mass ratio, spin, distance, orbital phase, among others. This work proposes to estimate the mass ratio of colliding binary black-holes (BBH) using an artificial neural network (ANN) algorithm which is trained with a waveform dataset created from numerical relativity. A systematic evaluation with different architectures of feedforward-nets and deep neural networks was made to assess the algorithm performance. Preliminary results indicate a mean square error (MSE) of 0.2 solar masses in the estimations and a correlation coefficient of 0.85 between the estimations and the parametrical data. We conclude that it is possible to use a supervised learning approach to estimate parameters of BBH from GW waveforms.

E.3 **Diana Alvear Terrero (Cuba)**

On slowly rotating magnetized white dwarfs

We use Hartle's formalism to study the effects of rotation in the structure of magnetized white dwarfs within the framework of general relativity. The inner matter is described by means of an equation of state for electrons under the action of a constant magnetic field, which breaks the SO(3) symmetry and introduces a splitting of the pressure into one parallel and other perpendicular to the magnetic field. Solutions correspond to typical densities of white dwarfs and values of magnetic field below 10^{13} G, considering perpendicular and parallel pressures independently, as if associated to two different equations of state. Rotation effects obtained accounts for an increase of the maximum mass for both, magnetized and non-magnetized stable configurations, up to about $1.5M_{\odot}$. Further effects studied include the deformation of the stars, which become oblate spheroids and the solutions for other quantities of interest, such as the moment of inertia, quadrupolar momentum and eccentricity. In all cases, rotation effects are dominant with respect to those of the magnetic field.

E.4 **Tiffany R. Lewis (USA)**

A First-Principles Spectral Model for Blazar Jet Acceleration and Emission with Klein-Nishina Scattering of Multiple Broad Line Region Emission Lines

Blazars are a sub-class of active galactic nuclei, with a polar jet aligned along our line of sight. Emission from blazar jets is observed across the electromagnetic spectrum. In our model we assume that the emission emanates from one homogeneous zone in the jet, which is in the process of passing through the Broad Line Region (BLR). We start from first principles to build up a particle transport model, whose solution is the electron distribution, rather than assuming a convenient functional form. Our transport model considers shock acceleration, adiabatic expansion, stochastic acceleration, Bohm diffusion, synchrotron radiation, and Compton scattering of seed photons from the BLR and dusty torus. We obtain the steady-state electron distribution computationally, and calculate individual spectral contributions due to synchrotron with self-absorption, disk, synchrotron self-Compton, and external-Compton emission, using numerical integration. We compare the resulting radiation spectrum with multi-wavelength data for 3C 279, during quiescence and two flares. Our preliminary results suggest that the jet power is strongly matter dominated, in contrast to equipartition assumptions. In particular, we find that detailed modeling of the electron distribution is necessary to reproduce the SEDs, and modeling the BLR structure is necessary to accurately predict the location of the emitting region.

E.5 **Israel Martinez-Castellanos (USA)**

HAWC first results highlights

The High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC), located at an altitude of 4100m on the flanks of Pico de Orizaba, the highest mountain in Mexico, is sensitive to gamma rays between 100GeV and 100TeV, has a wide instantaneous field of view covering 15% of the sky and a duty cycle of ~95%. This work will provide an overview of HAWC features and the results from close to two years of operations. Among these is the release of a sky map with ~40 sources, including ~15 new ones; search and detection of transient events, as well as characterizing the variability of known sources; limits on the high energy emission of the Northern Fermi Bubble; and indirect limits on dark matter annihilation and decay.

E.6 **Karthik Ramanathan (USA)**

First Direct-Detection Constraints on eV-Scale Hidden-Photon Dark Matter with the DAMIC experiment at SNOLAB

We discuss recent direct detection constraints on the absorption of hidden photon dark matter (an alternative dark matter candidate), with particle masses in the 1.2-30 eV range, from the DAMIC (Dark Matter in CCDs) experiment at SNOLAB. Under the assumption that local dark matter is entirely composed of hidden photons, and using a novel methodology of placing constraints based on measured dark/leakage current – we report the most stringent direct detection constraints on hidden-photon dark matter in the galactic halo with masses 3-12 eV and provide the first demonstration of direct experimental sensitivity to ionization signals <12eV from dark matter interactions.

Session F: Life Sciences and Biophysics

Thursday, 17 August, 16:40 - 18:10 (Capitol Room)

F.1 **Udaya Raj Dahal (USA)**

Coil-helix transition of PEO upon nanoconfinement: Molecular dynamics simulations

Polyethylene oxide(PEO) is capable of forming hydrogen bonds with water. The structure of this biocompatible polymer strongly depends on the extent of hydration. Under nanoconfinement PEO as well as solvent will have less degree of freedom which significantly alter the behavior from solution. Using atomistic molecular dynamics simulations, we investigate the behavior of PEO in solution and under confinement using single walled carbon nanotube(CNT). When exposed to CNT, we find PEO entering the CNT from solution spontaneously when one end of PEO finds the opening of the CNT. The conformation inside the nanotube varies from rod-like in narrow tube to helical and wrapped chain conformation as the CNT diameter increases gradually. The helical conformation in CNT is attributed to the stable water arrangement where one water molecule forms two hydrogen bonds with PEO oxygen. This sort hydrogen bonding which binds water strongly to PEO and makes the water molecules more stable than in solutions mimicking the intramolecular hydrogen bonding in DNA helix. We will further discuss the details about the water stability, residence lifetime and the modification of scaling law for PEO under confinement.

F.2 **Zegnet Yimer Muhammed (USA)**

Study on dioxygen binding to heme using SCAN functional

Density functional theory, a quantum mechanical based electronic structure method with GGA-PBE and MGGA-SCAN functionals, are used to investigate the structure and energies of singlet, triplet, and quintet spin states of FeP (iron Porphyrin), FePIm (imidazole iron porphyrin), and $FePImO_2$ (dioxygen imidazole iron porphyrin) systems. The binding and release of dioxygen to and from hemoglobin (Hb) are the most crucial reaction takes place in human body to sustain the existence of life. $FePImO_2$ is used to model this phenomenon. When O_2 binds to FePIm, the system undergoes a conformational change. i.e. from domed structure of FePIm in which the Fe atom moves away from the porphyrin plane to a planar structure of singlet $FePImO_2$ in which the Fe atom lies on the porphyrin plane. Quintet $FePImO_2$ resembles FePIm due to the pronounced movement of Fe atom above the porphyrin plane. GGA-PBE functional correctly predict the ground states of FeP (S=1) and $FePImO_2$ (S=0) that agrees with experimental data but failed to predict the ground state of FePIm (S=2). On the other hand, MGGA-SCAN functional correctly predict the ground states of FeP (S=1) and FePIm (S=2) that are agreed with experimental results but failed to predict the ground state of $FePImO_2$ (S=0).

F.3 **Manuel Martínez-Jiménez (México)**

Simulations of water-methanol mixtures with potentials fitted to reproduce the dielectric constants of pure liquids under ambient temperature and pressure

Classical molecular-dynamics simulations were used to study thermodynamic, dynamic and structural properties of the water-methanol liquid mixtures, as a function of the MeOH molar fraction, in the entire range of composition. Unlike previous studies in existing literature, in this work were used models which reproduce the experimental value of dielectric constant for each component (T=298.15 K y p=1 bar), the TIP4P/ε model of water and we introduce two new models of methanol: the first one was designed from ab-initio calculations whereas the second model was based on the recent OPLS/2016 potential for methanol. The results present good agreement for several properties of pure liquid methanol: density, dielectric constant, critical temperature, surface tension and coexisting densities. Mixture densities and dielectric constants for the mixtures resulted in good agreement with experimental data in the entire range of composition, while diffusion constants and excess volumes and enthalpies of mixing evidenced the limitations of non-polarizable models for a quantitative reproduction, suggesting the inclusion of explicit polarizability to achieve a better description.

F.4 **Clay S. Miranda Contee (USA)**

Application of Neural Network and Deep Learning Algorithms to Nodule Localization in Simulated and Real X-ray Radiographs

Currently the five-year survival rate for lung cancer patients is 55% for early detection. However, only 16% of lung cancer cases are discovered early, largely due to inadequacies in imaging modalities and subsequent data processing. In dual-energy X-ray imaging, materials are discriminated by the difference in transmitted low and high energy X-ray spectra. Energy independent constants of the two spectra characterize the integrated Compton scattering and photoelectric attenuation coefficients of the material. However, Compton scattering cross sections equal photoelectric absorption cross sections at a crossing energy that depends on Z, and is less than 100 keV for predominant elements in the human body; because diagnostic radiology occurs mainly in the 10-100 keV range, consideration of both energy dependencies ought to be considered. This work investigates the potential of distinguishing tissues based on the detailed energy dependence of photoelectric and inelastic scattering cross sections. Among other applications, these considerations can then be used to design multi-energy imaging modalities that potentially can be used to train artificial neural nets for virtual-dual-energy processing of chest X-rays. Algorithm are tested in simulated and/or real X-ray radiographs with a focus on regions of overlap between lungs and ribs/clavicles, where most false positives in lung radiographs occur.

F.5 **Sudip Pandey (USA)**

Magnetic, Structural, and Magnetocaloric Properties of Ni-Based Thermoseeds for Self-Controlled Hyperthermia

A number of ferromagnetic alloys in the bulk-form "thermoseeds" have been investigated for localized self-controlled hyperthermia treatment of cancer by substituting V, Mo, Cu, Si, Al, and Ga for Ni. The structural, magnetic, and magnetocaloric properties of the samples were studied, using room temperature X-ray diffraction and a Superconducting Quantum Interference Device (SQUID) magnetometer. The magnetocaloric parameters (magnetic entropy changes, refrigeration capacity (RC), and hysteretic effects) have been calculated. It has been shown that recrystallization, i.e., annealing time and temperature, is crucial for controlling the heating characteristics of the seeds. A linear decrease in Curie temperature (TC) from 380 K (107 °C) to 200 K (-73 °C) was observed with increasing substitution of Ni by V, Mo, Cu, Si, Al, and Ga, while the magnetization value remained nearly constant. The optimal composition of these Ni-based alloys has been determined in order to allow self-controlling hyperthermia, implying a Curie temperature near the therapeutic level, 315-318 K (41-45 °C). The results showed that an extraordinary self-regulating heating effect has been achieved in Ni-based magnetic materials, which may create new vistas for hyperthermia cancer treatment. Acknowledgement: This work was supported by the Office of Basic Energy Sciences, Material Science Division of the U.S. Department of Energy, DOE Grant No. DE-FG02-06ER46291 (SIU) and DE-FG02-13ER46946 (LSU).

F.6 **Pejman Sanaei (USA)**

Curvature and stress driven tissue growth in a tissue engineering scaffold pore

Cell proliferation within a porous tissue engineering scaffold perfused with nutrient solution depends sensitively on the choice of pore geometry and flow rates: regions of high pore curvature encourage cell proliferation while a critical flow rate is required to promote growth. When the flow rate is too slow the nutrient supply is limited; too fast and the cells become damaged due to the high shear. As a result, determining appropriate tissue engineering scaffold geometries and operating regimes poses a significant challenge that cannot be addressed by experimentation alone. We present a mathematical theory for the fluid flow within a pore of a tissue engineering scaffold, which is coupled to the growth of cells seeded on the pore walls. In addition, we exploit the slenderness of a pore that is typical in such a scenario, to derive a reduced model that enables a comprehensive analysis of the system to be performed. Furthermore, we also demonstrate how the simplified system may be used to suggest improvements to the design of a tissue engineering scaffold and the appropriate operating regime.

Session G: Condensed Matter, Fluids and Complex Systems

Friday, 18 August, 10:35 - 12:05 (Congressional B)

G.1 **Pascal Nigge (Canada)**

Evidence for superconductivity in Li-decorated monolayer graphene

Monolayer graphene exhibits many spectacular electronic properties [1], with superconductivity being arguably the most notable exception. It was theoretically proposed that superconductivity might be induced by enhancing the electron–phonon coupling through the decoration of graphene with an alkali adatom superlattice [2]. Although experiments have shown an adatom-induced enhancement of the electron–phonon coupling [3], superconductivity has never been observed. Using angle-resolved photoemission spectroscopy (ARPES), we show that lithium deposited on graphene at low temperature strongly modifies the phonon density of states, leading to an enhancement of the electron–phonon coupling of up to $\lambda \simeq 0.58$. On part of the graphene-derived ϖ^*-band Fermi surface, we then observe the opening of a $\Delta \simeq 0.9$-meV temperature-dependent pairing gap [4]. This result suggests for the first time, to our knowledge, that Li-decorated monolayer graphene is indeed superconducting, with $T_c \simeq 5.9$ K.

G.2 **Min Prasad Khanal (USA)**

Study of gamma-ray irradiation effects on AlGaN/GaN high electron mobility transistors

Excellent radiation hard properties make AlGaN/GaN High Electron Mobility Transistors (HEMTs) promising candidates for the radiation harsh electronics. In this research, 120 MRad (Air) gamma-ray irradiation-induced effects on HEMTs were studied via optical and electrical techniques. Micro-Raman spectroscopy was used to examine the crystal quality, and the photoluminescence (PL) spectroscopy was performed to investigate the crystal quality and the defects concentration. Spectroscopic photo current–voltage (SPIV) and transistor dc characteristics were measured on virgin and the irradiated Schottky and transistor devices, respectively. Degradation in crystal quality of the irradiated sample was speculated from the relative broadening of the FWHM of Raman and PL peaks. The PL results suggest the alternation in defect distribution after the irradiation and also the SPIV measurement revealed the pre-existence of sub-bandgap defects and their alternation caused by the gamma ray, which possibly caused a decrease in transistor dc characteristics. Also, the reduction in carrier concentration, mobility, and the positive shift in threshold voltage was observed from the gamma irradiated samples. It is concluded that although the AlGaN/GaN HEMTs are relatively less vulnerable to the gamma irradiation, relatively high dose gamma-irradiation can introduce additional traps or re-configure the pre-existing traps, affecting the electrical and optical characteristics of the HEMTs devices.

G.3 **Juan Carlos Sandoval Santana (México)**

Detection of electron-nuclear spin oscillations of Ga paramagnetic centers in GaAsN: Master equation approach

Points defects in semiconductors are excellent candidates to model quantum registers due to the hyperfine interaction that couples their electronic and nuclear spins. Recently, It has been shown that this coupling can be used to transfer electronic and nuclear spin in order to control the electron spin coherence time of impurity atoms in silicon and nitrogen-vacancy centers in diamond. Similarly, in GaAsN alloys, the hyperfine interaction plays a decisive role in the spin dynamics of Ga deep paramagnetic centers. In this work, we propose a model based on the master equation approach to describe the dynamical behavior of electronic and nuclear spin polarization in GaAsN. Our model suggests that the hyperfine interaction between bound electrons and nuclei in Ga centers plays a key role in the spin polarization of conduction band electrons. In addition, we demonstrate that the nuclear spin polarization of the gallium defects can be tuned through the optically induced spin polarization of conduction band electrons. Based on our models results we propose an experimental protocol based on a pump-probe photoluminescence scheme that would allow the detection and the tracing of the electron-nucleus flip-flops through time-resolved photoluminescence measurements in the absence of external magnetic fields and without using electron spin resonance techniques.

G.4 **Eduardo Javier Domínguez Vázquez (Cuba)**

Cluster Variational Method for disordered quantum systems

Based on the well known Cluster Variational Method [1] and with the aim at describing the local properties of disordered quantum models we develop an equivalent of a message passing algorithm that can be regarded as an extension of the Generalized Belief Propagation[2] for quantum spin systems. This technique allows for the determination of microscopic observables with better results than the standard mean field approach. To the level of the Bethe approximation for tree-like and finite dimensional lattices we obtain numerical results for the transverse ferromagnet and the random field Ising Model that are in good agreement with the quantum cavity method[3] and stochastic Monte Carlo simulations. We also report the results obtained for the plaquette approximation in two dimensional lattices. [1] Pelizzola A 2005 *J. Phys. A: Math*. Gen. 38 R309; [2] Yedidia J, Freeman W T and Weiss Y 2005 IEEE Trans. Inf. Theory 51 2282; [3] F. Krzakala, A. Rosso, G. Semerjian and F. Zamponi, *Phys. Rev. B* 78, 134428 (2008).

G.5 **Thomas Nevins (USA)**

Dynamics of reaction front growth in unsteady flows

When a growing reaction is spread by fluid flows, it generally exhibits complex dynamics. Phytoplankton in the ocean shoot off long filaments of rapid spreading, and wildfires suddenly change direction with the winds. In each case, growth rates (chemistry and biology) govern the eventual dynamics (the physics). These applications also tend to have interactions with flows that further complicate their dynamics. In this talk, I will show how the movement of reaction fronts can inform our understanding of underlying chemistry, and how unsteady flows modify that movement. I will first present experimental results from tracking reactions growing without flow. We have made an algorithm for tracking reaction fronts over time, and obtaining local measurements of two front properties: velocity and thickness. I will show how well known solutions to certain reaction-diffusion equations in one dimension can use these properties to accurately measure microscopic quantities: diffusivity and reaction rate. The first order effects of flow can be then be understood by measuring flow and reaction simultaneously. Reaction fronts are moved along a measured velocity field, and then the stagnant algorithm can be applied. The differences are due to nonlinear effects, and as flows become non-laminar, these effects become defining elements of the reaction. For example, I will show how different chemistries create different growth patterns.

G.6 **Brian Weston (USA)**

Physics-Based Numerical Simulations of the Selective Laser Melting Process in Metal 3D Printing

Physics-based numerical simulations associated with metal additive manufacturing processes (3D printing) such as selective laser melting and other laser-induced phase change applications present significant challenges. Simulations of the laser melting process require state-of-the-art numerical methods to track multiple solid-liquid-gas interfaces, due to laser-induced phase change (melting/solidification and evaporation/condensation) of metal powder in an ambient gas. Multi-physics problems, such as modeling the physics in the laser melting problem, are computationally challenging and require the solution of a system of nonlinear, tightly-coupled partial differential equations. Due to the wide variety of time scales associated with the Navier-Stokes equations, traditional explicit in time methods are impractical for these stiff systems, which have severe time step limitations due to numerical stability requirements. Large-scale simulations are thus prohibitively expensive and require months of high-performance computing time. Fully-implicit algorithms, however, are an attractive candidate and allow time steps to be chosen based on accuracy instead of stability. The resulting system of linear equations, however, is typically ill-conditioned and difficult to solve. My research focuses on designing a preconditioner to solve the system of equations more efficiently. This preconditioner will enable the ability to simulate 3D multi-physics simulations of the laser melting process.

Session H: Quantum Information and Gravitation

Friday, 18 August, 10:35 - 12:05 (Congressional CD)

H.1 **Ana Avilez-Lopez (México)**

Ultra-light scalar-field configurations as seeds of galactic haloes and their super massive black holes guests

Several observations suggest the existence of central super-massive black holes in giant galaxies. Usually the formation of these objects is still non completely well understood. In our research we propose an alternative of formation of SMBH. The initial idea is that a black hole forms from the collapse of a primeval self-gravitating configuration of an massive self-interacting scalar field which obeys the Klein-Gordon equation. At very low temperature all these bosonic excitations lay in ground state and hence they form a Bose-Einstein condensate. It has been shown that the accretion rate of the system is very slow and therefore the configuration surrounding the black hole has a lifetime as large as the age of the Universe. In this talk an application of these ideas is presented in the context of galaxies hosting super massive black holes. We suppose that the galactic halo is a Bose-Einstein condensate which started to collapse in the early early Universe and continues collapsing into a SMBH until now. We construct a model for the galactic system using solutions of an scalar field in a Schwarzschild space-time. This is applicable to systems out of their accretion-phase at late times. Finally, we use the previous model to compute the stellar velocity dispersion of stars induced by the gravitational potential well potential of scalar field dark matter and the black hole for some realistic cases.

H.2 **Saoussen Mbarek (Canada)**

Thermodynamic Volume of Cosmological Solitons

We present explicit expressions of the thermodynamic volume inside and outside the cosmological horizon of Eguchi-Hanson solitons in general odd dimensions. These quantities are calculable and well-defined regardless of whether or not the regularity condition for the soliton is imposed. For the inner case, we show that the reverse isoperimetric inequality is not satisfied for general values of the soliton parameter a, though a narrow range exists for which the inequality does hold. For the outer case, we find that the mass M_{out} satisfies the maximal mass conjecture and the volume is positive. We also show that, by requiring M_{out} to yield the mass of dS spacetime when the soliton parameter vanishes, the associated cosmological volume is always positive.

H.3 **Christopher Pugh (Canada)**

Airborne Demonstration of a Quantum Key Distribution Receiver Payload

Demonstrations of quantum key distribution (QKD) with moving platforms are important to prove the viability of future satellite implementations. Thus far these demonstrations of QKD to aircraft have operated exclusively in the downlink configuration, where the quantum source and transmitter are placed on the airborne platform. While this approach has the potential for higher key rates, it is more complex and is not as flexible as an uplink configuration, which places the quantum receiver on the airborne platform. Here we present the first successful demonstration of QKD to a receiver on a moving aircraft. The airplane flew two path types: circular arcs around the ground station, and lines past the ground station. The distances for each type of pass varied from 3 to 10 km. In total, we generated finite-size secure key in 5 passes, with one showing over 800 kbit. The circular passes allowed for longer link times, whereas the line passes were more representative of a satellite pass over a ground station. Angular speeds (at the transmitter) between 0.4°/s and 1.28°/s were achieved. The major components in the receiver (fine pointing unit, integrated optics assembly, detector modules, control and data processing unit) have a clear path to flight.

H.4 **Lucas Hackl (USA)**

Typical eigenstate entanglement of spinless fermions

In a seminal paper, Don Page computed the entanglement of typical states representing all states in the Hilbert space and found that these are maximally entangled in the thermodynamic limit. In our work, we study the entanglement entropy of eigenstates of spinless fermion Hamiltonians and find that the entanglement of typical eigenstates is vastly different from typical states in the Hilbert space. We prove this by deriving analytical bounds of the entanglement entropy averaged over all eigenstates as a function of the subsystem size.

H.5 **Aleksander Kubica (USA)**

Three-dimensional color code thresholds via statistical-mechanical mapping

Three-dimensional (3D) color codes have advantages for fault-tolerant quantum computing, such as protected quantum gates with relatively low overhead and robustness against imperfect measurement of error syndromes. Here we investigate the storage threshold error rates for bit-flip and phase-flip noise in the 3D color code on the body-centered cubic lattice, assuming perfect syndrome measurements. In particular, by exploiting a connection between error correction and statistical mechanics, we estimate the threshold for 1D string-like and 2D sheet-like logical operators to be p1 = 1.9% and p2 = 27.5%. We obtain these results by using parallel tempering Monte Carlo simulations to study the disorder-temperature phase diagrams of two new 3D statistical-mechanical models: the 4-body and 6-body random coupling Ising models.

H.6 **Ramy Tannous (Canada)**

Bright entangled photon source using PPLN for quantum communications

We report on a source of narrow-band infrared photon pairs generated by a periodically-poled Lithium Niobate nonlinear crystal doped with Magnesium Oxide in a waveguide configuration. The source is designed to be compatible with free-space Quantum Key Distribution links, with signal and idler photons being 785nm and 836nm, respectively. Our results indicate a high brightness and efficient source, which makes it a very good candidate for free-space Quantum Communication.

Session I: Atomic, Molecular and Optical Physics

Saturday, 19 August, 10:35 - 12:05 (Congressional B)

I.1 **Hermina C. Beica (Canada)**

Applications of auto-locked diode lasers

Our group has developed an interference filter (IF)-stabilized diode laser which can be used with an auto-locked controller for precision spectroscopy. Our unique vacuum-sealed laser cavity design uses an interchangeable base-plate that allows the laser diode and optical elements to be selected for operations at desired wavelengths. A narrow-band IF provides the feedback light to the laser diode to narrow the output frequency to ~500 kHz. The IF can be tuned from outside the laser cavity to fine-adjust the output wavelength once the laser cavity has been evacuated. To stabilize the laser frequency, the auto-lock controller applies corrections based on first- or third-derivative feedback, or through a pattern-matching algorithm stored in memory. We have developed IF laser systems at wavelengths of 633 nm and 780 nm, for spectroscopy in iodine and rubidium, respectively. We present Allan deviation measurements of the beat note and the lock stability for the 780-nm system. Additionally, we demonstrate that the IF lasers can be the basis for a new class of lidar transmitters, where a temperature-stabilized fiber-Bragg grating (FBG) is used to generate frequency markers for on-line points of the transmitter. We have calibrated the FBG spectra with reference to atomic transitions and present a 10-minute frequency lock to the FBG peak. This demonstration is the first step toward realizing a dial-type lidar transmitter.

I.2 **Chelsea Liekhus-Schmaltz (USA)**

Coherent control around a conical intersection using kinetic energy and the geometric phase

Conical intersections (CIs) between molecular potential energy surfaces generally occur in any molecule consisting of at least three atoms. They are used to describe fundamental molecular dynamics, such as photofragmentation and isomerization. However, few studies have used the features of a CI as a tool for coherent control. Here we describe two modes of control around a conical intersection in acetylene in a time dependent Schrodinger equation simulation. The first uses a continuous light field to control the population on the two intersecting electronic states. The second uses a pulsed light field to control wavepackets that are subjected to the geometric phase shift in transit around a CI. This second technique is likely to be useful for studying the role of nuclear dynamics in electronic coherence phenomena.

I.3 **Midhat Farooq (USA)**

Application of Optical Mangetometry to a Particle Physics Experiment

A low-field ^{3}He magnetometer was developed at the University of Michigan by employing a widely used technique called Metastability Exchange Optical Pumping (MEOP) for the hyper-polarization of ^{3}He gas. The polarization is followed by NMR to determine the frequency proportional to the magnetic field in which the probe is placed. Currently, low (~30 G) magnetic fields have been measured successfully to 0.1 ppm, and a modified probe design for operation in high fields is under development at Argonne National Lab. The future plan involves studies of systematic uncertainties to attain an error budget of less than 30 ppb for the final measurement. The goal of the project is to cross check the absolute calibration of the magnetic field measurement in the muon g-2 experiment (E989) at Fermilab, which requires a precise measurement of the 1.45 T field of the muon storage ring to 70 ppb. The final field measurement of E989 will employ multiple absolute calibration probes: two water probes and the ^{3}He probe. The ^{3}He probe offers a cross-check of the water probes with different systematic corrections, adding a level of confidence to the measurement. The project is unique as it connects the fields of particle physics and optical magnetometry.

Parallel Session Abstracts

I.4 **Hugh Podmore (Canada)**

Compressive-sensing on-chip Fourier-transform spectrometers

We describe recent advances in the development of two on-chip spectrometers for compressive-sensing (CS) Fourier-transform spectroscopy. The spectrometers are implemented as arrays of Mach–Zehnder interferometers (MZIs) integrated on photonic chips. We detail the advantages of this implementation in terms of mass and volume budgets, as we all as ease of implementation from a CS standpoint. The signal from a set of MZIs comprises an undersampled discrete Fourier interferogram, which we invert using l_1-norm minimization to retrieve a sparse input spectrum such as a laser line or Raman signal. We demonstrate the retrieval of three sparse input signals by collecting data from restricted sets of MZIs and applying common CS reconstruction techniques to this data. In the first device, we demonstrate that this retrieval maintains the full resolution and bandwidth of the original device, despite a sampling factor as low as one-fourth of a conventional (non-compressive) design. We also present the details of a second device, a CS Fourier-transform on-chip Raman spectrometer which has been uniquely designed from the ground up as a CS spectroscopy platform.

I.5 **Silvia Cortés-López (México)**

Nonlocal dielectric response of a high-temperature superconductor slab

Layered high-temperature superconductors can be used to construct negative refractive index metamaterials. Such kind of metamaterials have unusual optical properties due to their negative refraction, which allows us to control light propagation. This property is of interest for cloaking devices and superlens development. In fact, a layered high-temperature superconductor slab exhibits negative refraction in the THz frequency range. In this work, we theoretically studied the nonlocal dielectric response of a high-temperature superconductor slab in the frequency range where the superconducting slab has negative refractive index. The nonlocality of the inherently-anisotropic layered superconductor comes from the wave vector dependence of its permittivity tensor. As a result of the spatially-dispersive (nonlocal) dielectric response of the superconductor slab, additional electromagnetic modes are generated in the p-polarization geometry. The calculated p-polarization THz spectra show very narrow resonances associated with the quantization of the wave vectors of long-wavelength electromagnetic modes, having negative dispersion, and short-wavelength additional (nonlocal) modes of positive dispersion, in the frequency interval just above the Josephson plasma frequency of the superconductor. We have found that the quantized electromagnetic modes are quasi-longitudinal because of the strong anisotropy in the nonlocal dielectric response of the high-temperature superconductor.

I.6 **Sirak M. Mekonen (USA)**

Studies of nonlinear optics in sorted single walled carbon nanotubes via z-scan technique

The nonlinear optical properties of CNTs make them ideal materials for the realization of potential applications such as saturable absorbers for mode-locking applications and optical limiting for laser safety or sensor protection. The overall material science of CNT synthesis has improved vastly, providing a greater control in fabrication with respect to scalability, chirality, electronic type, individualization etc. Although advancements have been made with respect to nonlinear optics in CNTs, there are still open topics such as: the possibility of all metallic CNT saturable absorbers, exploring chirality dependence for low intensity/CW optical limiting properties, can modifying the dielectric constant effect the nonlinear optical properties, etc. Here, we present the nonlinear optical properties of CNTs using the z-scan measurement technique where we can simultaneously measure the physical parameters of nonlinear refractive index (n_2) and nonlinear absorption coefficient (β) through detection of the transmittance with closed and open apertures respectively. Specifically, we present the influence of alkanes, water and air on the nonlinear properties of CNTs. We found that the is highest nonlinearity occurs for alkane-filled nanotubes. We also present the nonlinear properties of alkane-filled CNT thin films whereβ is 3 orders of magnitude higher than for its solution form and more applicable for future photonic devices.

Session J: Earth, Energy, and Environment

Saturday, 19 August, 10:35 - 12:05 (Congressional CD)

J.1 **William Elcock (Canada)**

The Effect of Perovskite Cuboid Formation on J-V Hysteresis in Perovskite Solar Cells

Perovskite solar cells may exhibit current density-voltage hysteresis which makes it difficult to determine their true power conversion efficiency. Depending on the method of deposition used for the perovskite layer, the level of hysteresis can vary. Scanning electron microscopy (SEM) has revealed perovskite films consisting of cuboid structures, which may form depending on the deposition method used for the perovskite active layer. This is the case with methylammonium lead iodide ($CH_3NH_3PbI_3$) perovskite solar cells where the $CH_3NH_3PbI_3$, perovskite layer is deposited via sequential spin-coating of solutions of first, lead iodide, then methyl ammonium iodide (CH_3NH_3I). $CH_3NH_3PbI_3$ cuboids varying in size are observed in this case, depending on the CH_3NH_3I solution concentration. Bigger cuboid structures (longest side approaching 1μm) have been shown to result in low levels of hysteresis, while smaller structures have been shown to result in a larger degree of hysteresis. Reduced hysteresis has also been observed in solar cells with a $CH_3NH_3PbI_3$ layer fabricated via one step spin coating of a solution of $CH_3NH_3PbI_3$ and CH_3NH_3I, with added hydroiodic acid. In this case, SEM revealed cuboid structures whose longest sides are as large as about 5μm. This work explores the dependence of J-V hysteresis in perovskite solar cells on $CH_3NH_3PbI_3$ cuboid size in the context of the two step, and one step deposition methods described above.

J.2 **Yuliana Pineda Galvan (USA)**

Spectroscopic studies of Ru-based water oxidation catalysts for artificial photosynthesis

Green plants convert sunlight into chemical energy in the process of photosynthesis. Key step of this process is water oxidation, which generates four protons, four electrons and dioxygen. It occurs in oxygen-evolving complex of Photosystem II. Replicating this process would enable widespread use of solar energy. Artificial water oxidation catalysts (WOC) have to be efficient and robust under extremely oxidizing conditions. Ruthenium-based complexes were the first WOCs discovered, and they have been extensively studied. However, they have to be significantly improved for practical applications. To design new WOCs, it is necessary to understand the catalytic mechanism of existing complexes and factors controlling their inefficiency and stability. In this work, Ru-based WOCs were studied at water oxidation conditions using spectroscopic methods, such as X-ray Absorption, Electron Paramagnetic Resonance and Resonance Raman spectroscopy. To model light-induced electron removal from the catalyst in photocatalytic system, catalyst is oxidized chemically or electrochemically. This approach allowed to establish intermediates in water oxidation process, but it also leads to catalyst degradation. For practical applications, molecular complexes have to be isolated. Several complexes deposited on the electrodes were studied and compared to molecular catalysts. Another approach that involves WOCs incorporated into porous structures of metal-organic frameworks will also be discussed

J.3 **Joyprokash Chakrabartty (Canada)**

An alternative approach to improve photovoltaic performance in multiferroic thin films

Inorganic ABO_3 perovskite materials exhibit exotic physical and chemical properties due to the charismatic crystal structures and thus offer exciting opportunities for spintronics, computer memory, sensors, microwave and photovoltaic (PV) device applications. Since the discovery of bulk photovoltaic (BPV) effect in non-centrosymmetric crystals, the perovskites including $BaTiO_3$ (BTO), $LiNbO_3$ (LNO), $BiFeO_3$ (BFO), $BiMnO_3$ (BMO), and $Pb(Zr,Ti)O_3$ (PZT) drew enormous interests in science as they exhibit larger-than-band gap photovoltages (up to 1000V) under homogeneous light illumination. Owing to retain insulating characteristics even in the dimensions down to nanometer scale, the charge carrier conduction in polar perovskites are extremely poor resulting in low photocurrent density generation typically in the range of nA/cm^2 to μA/cm^2. As result the power conversion efficiency (PCE) under 1 sun illumination (AM1.5G) in these material systems are extremely poor, typically less than 1%. Driven by these challenges, recent report showed the PCE of 3.3% in ferroelectric single layer Bi_2FeCrO_6 (BFCO) thin films, highest ever reported in any single layer polar material systems. In this presentation, we will show an alternative approach to improve the PCE of up to 4.2% in Bi-Mn-O composite films. Our results provide an alternative approach to yield high PCE in perovskite material systems.

J.4 **Kristel Izquierdo (USA)**

Constraining global mass anomalies using a Trans-dimensional Hierarchical Bayesian inversion algorithm

Constraining the mass distribution in the subsurface can provide important information about the physical and chemical state of a planet, and hint at its history and evolution. For many celestial bodies, the only data available to shed light on their interior structure is partial and noisy gravity data. With this data in mind, we developed an iterative trans-dimensional Hierarchical Bayesian method to perform global gravity inversions which can recover the mass distribution within the interior of a planet. The method can estimate several parameters including the number of mass anomaly objects, their location and magnitude, the noise of the input data, and the uncertainty and trade-offs in the resulting mass distribution. Compares different randomly chosen mass distributions and evaluates them according to their fit to the gravity field. There are significant advantages of using this algorithm versus a classical approach to gravity inversions in ill posted problems since the algorithm requires less prior information and because it quantifies how much we can trust the mass distribution resulting from modeling the input data. We evaluate this method in a global gravity inversion of a synthetic gravity field of the Moon and show that we can successfully recover the main characteristics of the expected interior mass distribution and the noise of the data even when totally ignorant about the location, magnitude and number of mass anomaly objects.

J.5 **Rahul Kashyap (USA)**

Rogue Fluctuations in Fermi-Pasta-Ulam-Tsingou Systems

Large destructive waves called rogue waves have been studied quite extensively in oceans and large lakes for some time now. They have also been shown to exist in optical lattices, Bose-Einstein condensates and financial markets. Along similar lines, we study long time dynamics of Fermi-Pasta-Ulam-Tsingou (FPUT) type discrete mass-spring systems, and show that we find “rogue fluctuations” (RF) in quasi-equilibrium. Using numerical simulations, we show that while large energy fluctuations, which we have called “hot spots” are quite common across many systems, a series of such fluctuations, called RFs, are ubiquitous to highly nonlinear systems. We also discuss how the formation of RFs in these systems is affected by the presence of phonons and show that while phonons in general act to suppress RFs, they enhance the formation of RFs when the linear and nonlinear terms become competitive.

Friday, 18 August, 16:00 - 18:00 (Congressional A)

P.1 **Alberto Batista Tomás (Cuba)**

A fractal approach for development analysis of tropical clouds

In meteorology, one of the most pursued goals is the extraction of the biggest amount of information, using the available means. We contribute to that objective by introducing new parameters that allows to characterize, based on visible spectra of satellite images, two very important families of clouds: cirrus and cumulonimbus. These parameters provide information about the morphology of the clouds, taking the fractal dimension big relevance. Nevertheless, other parameters such as circularity, convexity and filling are measured. We determined the fractal dimension for both families, and obtained clear differences in the results for each one. Also, we were able to explain the obtained values based on the internal dominating process of each family. An analysis of the methods for fractal dimension estimation was made, obtaining the relation between both of them, and the applicability range of the area-perimeter estimator. In addition, we study the behavior of the fractal dimension for groups formed by clouds belonging to different families. Regarding to the other parameters mentioned, the values characteristics to each family were measured, being these result very helpful in the creation of an automatic classification tool for each groups. After that, we verified that our results are not affected by the multifractality existent in the radiation field of the clouds. At last, we made, for the first time, the tracking of the fractal dimension of both group, during its lifetime.

P.2 **Carolina Bohórquez Martínez (México)**

Study of the electronic structure of undoped and Mn-doped ZnO and GaN

ZnO and GaN have long been considered as promising candidate materials for diluted magnetic semiconductors (DMS), owing to its theoretically predicted and experimentally observed ferromagnetism above room temperature, and its long spin coherence time. Scanning Tunneling Spectroscopy (STS) and cathodoluminescence (CL) techniques have been used in this work to study the electronic structure of undoped and Mn-doped ZnO and GaN. CL spectra from ZnO and ZnO:Mn revealed two emissions centered at about 3.2 and 2.2 eV, corresponding to the near band edge and point-defect emissions, respectively. We have attributed the defect related emission to the formation of oxygen vacancies (VO), which decrease in concentration after annealing at 800 °C in an O2 atmosphere. CL spectrum of the GaN film shows a single transition centered at 3.4 eV associated with the band edge of this semiconductor. CL spectra from GaN and GaN:Mn showed a band centered at 3.3 eV that corresponds the band edge of this semiconductor, besides the Mn-doped sample showed two emissions centered at 2.8 and 2.6 eV attributed to point defects generated by the Mn incorporation in the wurtzite structure. STS measurements from ZnO and GaN were carried under ultrahigh vacuum conditions and 77 K, revealing surface band gap values of about 3.0 and 4.0 eV. The magnetic domains of Mn-doped ZnO and GaN samples were observed by using the magnetic force microscopy (MFM) technique.

P.3 **Robert Caddy (USA)**

Time Series Photometry of the Symbiotic Binary NSV 11749

Photographic plates in the Harvard collection show the New Suspected Variable star NSV 11749 brightening by a factor of 100 in flux over four years starting in 1899, remaining at maximum for four years, then declining below the depth of the plates (Williams 2005). This behavior is very atypical for most variable stars and as a result there has been much debate over the exact nature of NSV 11749. This debate was potentially ended by the discovery of a Raman scattered emission line at 6824Å which is unique to symbiotic binaries (Bond & Kasliwal 2012) making NSV 11749 one of only 12 known symbiotic stars. Our research hopes to expand upon our knowledge of NSV 11749 through analysis of five years worth of multi-band optical time-series data. From this we should be able to find the period of this binary. This would confirm whether this it is a symbiotic binary or its closer orbiting cousin, a cataclysmic variable; furthermore, it would also allow us to characterize the cooler component of the binary. We will also determine the properties of any other variable stars near NSV 11749 of which there appear to be several by a visual inspection of our images.

Poster Session Abstracts

P.4 **Maria Magdalena Montsserrat Contreras Turrubiartes (México)**

Growth and Characterization of GaN and InN Thin Films grown by Atomic Layer Deposition

The III-V semiconductors has been studied extensively due to his characteristics and properties for potential applications in electronics. Atomic layer deposition is a new technique for growth of thin films, it allow us to make growths at low temperatures and with great structural quality. Indium Nitride and Gallium Nitride represents an important materials and his construction over new techniques using different precursors and lower temperatures is subject of study. In this work the proposal of new precursor for growth of InN and GaN shown, the process for determinate the temperature window and parameters of growth is also discussed, the growths were made over Si (100) and MgO substrates. Finally the results of characterization by Atomic Force Microscopy, Photoluminescence, SEM and Raman are presented.

P.5 **Paul Masih Das (USA)**

Low-Dimensional Black Phosphorus Nanostructures

Few-layer black phosphorus and its single-layer analogue, phosphorene, have garnered recent attention due to their highly tunable nature through a layer-dependent band gap and anisotropic carrier mobilities up to 1000 cm^2/Vs. We present here further control over the electronic and phononic characteristics of these materials through the fabrication of low-dimensional nanostructures such as nanopores, nanoribbons, and antidot arrays. Supported by density functional theory (DFT) calculations, we also develop and utilize oxidation-free fabrication and analysis techniques.

P.6 **Yesica Sonia Flores Meraz (México)**

Study of rare processes in extensions of the Standard Model with horizontal symmetry between families

There are many motivations to look for new physics beyond the Standard Model (SM), including for instance the hierarchy of masses, the number of free parameters, neutrino oscillations, dark matter, why there are three generations of elementary particles? Within the framework of an extension of the SM with a gauged SU(3) family symmetry commuting with the SM group, we study some rare flavor violating processes induced by the new scalars and gauge bosons, which can generate transitions between different families, and so induce ”Flavor Changing Neutral Currents”(FCNC) vertices at tree level. This Beyond Standard Model(BSM) proposal introduce a hierarchical mass generation mechanism where light fermions obtain masses from radiative corrections mediated by the massive bosons associated to the SU(3) family symmetry that is spontaneously broken. The main goal in this work is the study of some processes that violate a SM conservation law, like Lepton Flavor Violation (LFV). These class of processes are by nature very rare and thus very sensitive to tree level or higher order New Physics (NP) contributions. We analyze in detail $\mu \rightarrow eee$ and $\mu \rightarrow e\gamma$, which are strongly constrained from the experiments, and whose dominant contributions come from diagrams mediated by the gauge bosons with masses of the order of several TeV’s, corresponding to the lower scale of the SU(3) symmetry breaking. For these reasons, it is relevant to check the properly suppression of these rare decays.

P.7 **Carlos Alberto Gandarilla Pérez (Cuba)**

A Maxwell homogenization scheme for effective electro-elastic properties in nanocomposites

In this work, the effective material properties of a piezoelectric composite, consisting of nanowires embedded in a matrix, are evaluated using the Maxwell homogenization method (MHM). The MHM is an extension of a Maxwell scheme developed for transversally isotropic elastic composites [1] to piezoelectric composites. The volume fraction of nanowires is varied from 0 to a maximum of 1 and is considered with ellipsoidal geometrical form. The effect of volume fraction and aspect ratio of the reinforcement on composite overall properties are examined for distribution of aligned reinforcement. The numerical results obtained through Maxwell method are compared with the simulations obtained via the finite element method (FEM) micromechanics [2] and the effective medium self-consistent method [3]. The results can be applied to nanogenerators, which convert ambient mechanical energy into electrical energy. [1] C. A. Gandarilla-Pérez, R. Rodríguez-Ramos, L. Lau-Alfonso, F. J. Sabina. UDC 519.2 p. 25-38, (2017); [2] N. Mishra, B. Krishna, R. Singh and K. Das, (2017); [3] R. Rodríguez-Ramos, C. A. Gandarilla-Pérez and J. A. Otero-Hernandez, Math. *Methods Appl. Sci*., (2017). DOI: 10.1002/mma.4069.

P.8 **Yalina García Puente (Cuba)**

Physical properties of $BiFeO_3$-based multiferroic ceramic systems

Pure $BiFeO_3$ (BFO) and co-doped with Ba^{2+} and Ta^{5+} ions ($Bi_{1-x}Ba_xFe_{1-x/2}Ta_{x/2}O_3$), with x ranging from 0.04 to 0.15 at %, were prepared by using conventional solid-state reaction method from oxides and carbonates. The structural analysis of the $BiFeO_3$-based multiferroic systems was carried out by using X-ray diffraction at room temperature. A rombohedral perovskite structure has been evaluated for the BFO family system. It is showed that the intensity of the reflections related to undesired phases decreases gradually upon increasing the doping content. Structural distortions, which have been associated to the doping, were investigated through Rietveld refinement by using FullProof Suite Software. It is also discussed the effect of the doping on some important magnetic and ferroelectric parameters (i.e. Magnetic and Ferroelectric transition temperatures, T_N and T_C, respectively) considering the doping-content dependence for some of the refined structural parameters. The doping elements have also showed an important influence on the characteristic magnetic hysteresis, which was evaluated at room temperature.

P.9 **Nancy García-Zúñiga (México)**

Dosimetry evaluation of intensity-modulated radiation therapy vs volumetric-modulated arc therapy for stereotactic corporal radiation therapy treatments

Stereotactic body radiation therapy (SBRT) is an emerging high-precision technique that has been implemented in a few radiotherapy centers in Mexico due to their high technological requirements and the highly-specialized personnel involved. The aim of SBRT is to deliver high radiation doses, in a reduced number of fractions, to a small and well localized volume. Due to the high accuracy required, the enforcement of quality assurance controls is of utmost importance. The goal of this work was to perform a comparative analysis between SBRT treatments using Intensity-Modulated Radiation Therapy (IMRT) and Volumetric-Modulated Arc Therapy (VMAT) with flattening filter free beams, imparted by a TrueBeam™ Radiotherapy System (Varian Medical Systems). The dosimetry advantages offered by each technique were compared using both, the treatment planning system (TPS) and radiochromic film dosimetry. The evaluation with Eclipse™ TPS was performed using dose-volume histograms, conformity, homogeneity and gradient indices; and the dose inside and outside of PTV (Planning Target Volume). 2D-gamma index was used to compare the calculated by the TPS and the measured dose distributions using Gafchromic EBT-3™ and EBT-XD™ films.

P.10 **Roberto Gómez Rosales (México)**

Synthesis of Hydroxyapatite from Organic Materials

Hydroxyapatite (HAp) is the major mineral constituent of vertebrate bones and teeth. It has been well documented that HAp nanoparticles can significantly increase the biocompatibility and bioactivity of man-made biomaterials. In this research project the biodegradation of the sea shells, coral and eggs waste have been used eectively to produce hydroxyapatite nanostructure using two methods, microwave irradiation and solid state. The conversion of the sea shell into HAp is produced by the formation of calcium hydroxide. The preheated organic material is converted to hydroxyapatite by a chemical exchange reaction with diammonium phosphate under hydrothermal conditions or under microwave radiation. All the HAps were characterized by X-ray powder diraction (XRD) method, Fourier transform infrared (FT-IR) spectroscopy, Raman spectroscopy and Energy Dispersive X-ray Spectrometry (EDS). The product obtained, which contains carbonated HAp has numerous potential applications, such as material for biomedical applications in prothesis implants, it can be used as a medium for heavy metal absorption and absorbing and decomposing CO.

P.11 **Juan José González Armesto (Cuba)**

Electron transport in quantum rings modulated by bidimensional quantum point contacts

In this report we study the influence of the Aharonov-Bohm (AB) and the Aharonov-Casher (AC) phases on the interference mechanism for a semiconducting quantum ring (QR), in the presence of Rashba type of spin orbit interaction. A particular subject of investigation is the role of the 2D quantum point contacts (QPCs) to the transparency of the present device setup [1]. We additionally consider another QPC, allocated symmetrically at the ring periphery, thus conforming an additional control mechanism for the quantum oscillations in the ring. In addition to the expected conductance oscillations associated with the AB-AC effects, and the analysis of their behavior we discuss the interplay of the conductance with the barrier confinement strengths and QPC saddle-point height, which yields new and tunable harmonic patterns, while one manipulate these parameters. The role of the third QPC is thoroughly discussed as it changes both the shape of the patterns and the proper energies of the system [2]. We calculate the phase time associated with the travel of the electrons through the quantum ring. There are not known results for this quantity so its determination can lead to novel effects in the physics of quantum rings. This quantity exhibits a resonant behavior consistent with predictions for similar systems [3]. Finally, we investigate the appearance of anomalous patterns in the phase time, these can be associated with superluminal transport such as the Hartman effect or negative phase times. [1] L. Diago-Cisneros and F. Mireles, *J. Appl. Phys*., 114, 193706 (2013). [2] M. Buttiker, Y. Imry and M. Ya. Azbel, *Phys. Rev. A* 30, 4 (1984). [3] P. Pereyra, *Phys. Rev. Lett*., 84, 1772 (2000).

P.12 **Manuel Alfredo Hernández Wolpez (Cuba)**

Estimation of grain boundary angles in Bi-2223 superconducting ceramics by means of transport measurements

An estimation of GB angles in Bi-2223 ceramics by means of transport measurements is presented. The samples were obtained by solid-state reaction method. We used three set of samples: (set **A**) were obtained varying the compacting pressure, (set **B**) were obtained with different % wt of α-Al_2O_3 nanoparticles, and (set **D**) were obtained with two different % wt of Ca and Cu in the stoichiometric formula. The superconductor has been considered as a three-level superconducting system [1] composed by superconducting grains, superconducting clusters (intragranular defects as colonies of low-angle *c*-axis boundaries) [2], and weak links. The flux trapping curves [3], were obtained by measurements of the superconducting critical current density after applying and switching off magnetic fields, H_{am} < 500 Oe, in samples cooled at 77 K in zero field conditions. As a result of the brief theoretical framework [4] based in a Gurevich´s work [5], the independent variable of the flux trapping curves, H_{am}, may be transformed to θ_{min}. We were able to classify different types of vortices present in the flux trapping process of several Bi-2223 ceramic samples according to the analyzed range of H_{am}. The results also indicate two values of misorientation angle that exhibit a pronounced drop in the critical current density of the samples due to trapped flux. These boundary angles, 12◦ and 4◦, agree well with previous results obtained in bicrystals, thin films, and highly textured high T_c superconductors.

P.13 **Amara Katabarwa (USA)**

Quantum Projective Simulation with Hamiltonian Evolution

Projective Simulation was introduced as a novel approach to Artificial Intelligence. It involves a deliberation procedure that consists of a random walk on a graph of clips and allows for the learning agent to project itself into the future before committing to an action. Here we study and analyze a quantum mechanical version in which the random walk is performed by two kinds of Hamiltonians. The first kind is implemented by naively embedding the classical model in a quantum model by turning the clips into qubits. The other allows for storing clips in superpositions of qubits allowing for a purely quantum mechanical learning procedure in which the perception of the environment can purely quantum mechanical but the action is classical.

P.14 **Erick Javier López-Sánchez (México)**

Cable equation for general geometry

The cable equation describes the voltage in a straight cylindrical cable, and it has been used to model electrical potential in dendrites and axons. Sometimes this equation might give incorrect predictions for some realistic geometries, in particular when the radius of the cable changes significantly. Cables with a nonconstant radius are important for some phenomena, for example, discrete swellings along the axons appear in neurodegenerative diseases such as Alzheimers, Parkinsons, HIV associated dementia, and multiple sclerosis. Using the Frenet-Serret frame, we propose a generalized cable equation for a general cable geometry. We show that when the cable has a constant circular cross section, the first fundamental form of the cable can be simplified and the generalized cable equation depends on neither the curvature nor the torsion of the cable. Additionally, we find an exact solution for an ideal cable which has a particular variable circular cross section and zero curvature. For this case we show that when the cross section of the cable increases the voltage decreases. We study different cables with swelling and provide their numerical solutions. They show that when the cross section of the cable has abrupt changes, its voltage is smaller than the voltage on the cylindrical cable, and they also show that the voltage can be affected by geometrical inhomogeneities on the cable. Our results are consistent with experimental voltages reported in the literature.

Poster Session Abstracts

P.15 **Mayra Jacaranda Sánchez González (México)**

Radiative corrections to the β-energy spectrum in kaons decays

In this work we calculate the radiative corrections (RC) of the β-energy spectrum of the decay $K^+ \rightarrow \pi^0 e^+ \bar{\nu}_e$. The results which are model independent are presented up to order $(\alpha/\pi)(q/M_1)$, where q is the four-momentum transfer and M_1 the mass of the K^+. They are finite in the ultraviolet limit and do not present any infrared divergence. Our results could be used in a Monte Carlo simulation in order to determine the form factors or the V_{us} element of the CKM matrix.

P.16 **Nahid Shayesteh Moghaddam (USA)**

Electrical transport in NbTiN thin films

In this work we systematically investigate the superconducting properties of Niobium titanium nitride (NbTiN) thin films with different geometries. NbTiN films with a few nm thickness are widely used in devices such as superconductor-insulator-superconductor (SIS) mixers, superconducting cavities and resonators and superconducting nanowire single-photon detectors (SNSPD). In all these applications, films of varying/variable sizes are required to achieve high performance. The initial thickness of our samples was 125 nm deposited on silicon substrate. We change the width/length of our samples using lithography and ion milling method. We measure and analyze the thickness and width dependence of superconducting properties of our thin films using two different systems: PPMS (Physical Property Measurement System) and our Cryomech.

P.17 **Jacqueline Isamar Muro Ríos (México)**

A method based on classical entangled polarization modes and imaging to determine the Mueller matrix associated to transparent birefringent samples using a single incident beam

The experimental determination of the Mueller matrix of a transparent birefringent sample is presented. The novelty of this procedure is associated to the use of a single incident classically entangled polarized light (azimuthal unconventional polarization) and the presentation of results as spatially resolved polarization responses (images).This work shows the contributions of the spatial and polarizations degrees of freedom and the procedure to separate them from its localized, classical entanglement. Therefore, the independent manipulation of the spatial and polarization distributions of the beam, once it has interacted with the sample, allows the determination of the Mueller matrix with just one incident beam, contrary to the traditional polarimetric method, which needs to prepare at least 4 incident polarization states to interact with the sample. Results are compared with the traditional polarimetric method, showing the potential advantages associated to the method proposed here.

P.18 **Flavio Manuel Nava Maldonado (México)**

Nonlinear optical properties for asymmetric barrier heights in double zinc blende AlGaN/GaN quantum well

The nitride semiconductors are largely used in light emitting diode (LED) fabrication due to the differences in their energy gaps. We present a theoretical study of nonlinear absorption coefficient within the compact matrix density approximation for the electronic susceptibility that allows to obtain analytical expressions for the linear and the third order correction. In particular, we report the absorption coefficient for an asymmetrical double AlGaN/GaN rectangular quantum well as a function of the right-hand side well and central barrier widths, considering different barrier heights. For instance, we found that as we fix the left-hand side well width to 3 nm and the barrier width of 2nm, the off-diagonal electric dipole matrix element experiences an important rise for right-hand side well widths in the range of 2 to 4 nm. This suggests that such a configuration will improve the absorption of the system.

P.19 **Edwin Rodríguez Horta (Cuba)**

Application of computational mechanics to random Markov fields

This work presents a study about random Markov field systems from a computational mechanics perspective. The correlated biased random walk with latency in one and two dimensions is discussed with regard to the portion of irreducible random movement and structured movement [1]. It is shown how a quantitative analysis can be carried out by using computational mechanics. Complexity analysis allows to characterize the movement independently of the set of control parameters, making it suitable for the discussion of other random walk models. The stacking ordering problem in close packed structures is approached using two different models: layer pair interaction model [2] and individual layer interaction model [3]. Computational mechanics allows us to describe the stacking arrangement as an information processing system in the light of a symbol generating process. A general method to obtain the stochastic matrix from a generating functional is presented and then applied to problems at hand. The building of the epsilon-machine, has allowed a thorough discussion of disorder and polytipism within the models. This is something other approaches are unable to do. It also allows a powerful approach to the origins of polytipism in solids, and opens new venues into the understanding of an old problem. [1] E. Rodriguez-Horta et al, *Physica A* 458 (2016) 303; [2] E. Rodríguez-Horta et al. *Acta Cryst*. (2017). A73, 357; [3] E. Rodriguez-Horta et al. *Acta Cryst.* (2017) (accepted).

P.20 **Ramón Daniel Rodríguez Soto (México)**

Gravitational waves detector prototype based on Michelson interferometer

Gravitational waves (GW) derived from the linearized theory of General Relativity (GR) proposed by Albert Einstein in 1916, are perturbations of the space-time generated by oscillating massive objects. The scientific community worldwide has made significant progress to verify experimentally the analytical and physical implications resulting from the GR theory. Last year, these efforts resulted in the detection of GW generated during the merger of two black holes. This was possible thanks to interferometer-based GW detectors relying on the Michelson interferometer configuration, due to the geometry forces produced by GW, and its high sensitivity to phase difference caused by changes in the travel the time of light in its arms. We constructed GW academic prototype detector based on the Michelson configuration with rigid arms of 0.5m long, where we are recreating the effect of GW incident on it through motorized platforms that move linearly the interferometer arms mirrors. In this work we present the technological results obtained in the construction of the GW detector prototype using laser interferometry communicates the design principles of the LIGO Observatory and provides a demonstration of the wave nature of GW. First we give a brief description over the prototype development and we show the results obtained in the simulation and experimentation.

P.21 **Jose Guadalupe Rojas Briseño (México)**

Exciton energies in asymmetric zinc blende InGaN/GaN quantum wells

Nitride semiconductors are widely used in the fabrication of the light emitting diodes (LED's), but can be used to enhance solar cells properties also. Besides, exciton energy is an important quantity for the theoretical understanding for the solar cell absorption ranges. Asymmetric heterostructures based on semiconductors show particular electronic and optical properties, whereas exciton energies are also affected. We theoretically report exciton and binding energies in asymmetric step-like and double quantum wells configurations made of strained zinc blende InGaN/GaN. Exciton states were calculated by the variational method taking into account the mass- and dielectric-mismatch under effective mass and independent valence bands approximations. The uncorrelated electron-hole energies were obtained by a complete sinus base expansion. We find that for certain internal parameters the presence of either direct or indirect excitons, noticing these changes when in the variation of the binding energies appear maxima or minima.

P.22 **Alma Rocío Sagaceta-Mejía (México)**

Statistical foundations of Kaluza's magnetohydrodynamics: Thermoelectric and thermomagnetic effects

Kaluza prosed in 1921 that the particle charge-mass ratio is proportional to the fifth component of its velocity field. In this work we establish the constitutive equations that relate thermodynamic fluxes and forces up to first order in the gradients for simple charge fluids in the presence of electromagnetic fields. In Kaluza's approach, space-time curvature yields thermodynamic forces leading to generalizations of the well-known cross-effects present in linear irreversible thermodynamics.

P.23 **Monica Salinas Ibañez (México)**

Electric dipole moments of charged leptons at one loop in the presence of massive neutrinos

Violation of CP invariance is a quite relevant phenomenon that is found in the Standard Model, though in small amounts. This has been an incentive to look for high-energy descriptions in which CP violation is increased, thus enhancing effects that are suppressed in the Standard Model, such as the electric dipole moments of elementary particles. In the present investigation, we point out that charged currents in which axial couplings are different from vector couplings are able to produce one-loop contributions to electric dipole moments of charged leptons if neutrinos are massive and if these currents violate CP. We develop our discussion around charged currents involving heavy neutrinos and a *W′* gauge boson coupling to Standard Model charged leptons. Using the most stringent bound on the electron electric dipole moment, provided by the ACME Collaboration, we determine that the upper bound on the difference between axial and vector currents lies within ~ 10^{-10} and ~ 10^{-7} for heavy-neutrino masses between 0.5 TeV and 6 TeV and if the *W′* mass is within 0.45 TeV – 7 TeV. This possibility is analyzed altogether with the anomalous magnetic moments of charged leptons, among which we estimate, for the τ lepton, an anomalous magnetic moment contribution between ~ 10^{-8} and ~ 10^{-10} for neutrino masses ranging from 0.5 TeV to 6 TeV and a *W′* mass between 0.45 TeV and 7 TeV.

P.24 **Alan Ignacio Hernández Juárez (México)**

Chromomagnetic and Chromoelectric Dipole Moments in the Fourth Generation Two-Higgs Doublet Model

The discovery of a Higgs Boson with a mass of 125 GeV has confirmed the Standard Model (SM) as the right theory to describe electroweak interactions, however there are many unsolved problems, one of them is the invariance between matter and anti-matter in the universe (baryon asymmetry), according to Shakarov's criteria, the non conservation of CP invariance is a necessary requirement to explain it. CP violation is included in the SM by the complex phase of the CKM matrix but it is not enough to explain the baryon asymmetry, so it is important the study of new sources of CP violation beyond the SM. At the CERN Large Hadron Collider (LHC) the top quark is produced mainly through gluon-gluon fusion, so the LHC acts as a true top factory, producing hundreds of millions of top quarks every year. In this work we analyze the top quark chromomagnetic (CMDM) and chromoelectric dipole moments (CEDM) in the 4th generation two-Higgs doublet model (4G2HDM) where one of the Higgs doublets couples only to the fermions of the 4th family. In the SM the top quark CMDM is induced at one loop level while its CEDM appears only at the three-loop level. On the other hand in the 4G2HDM both CMDM and CEDM can appear at one loop level. The CEDM can only exist if CP is violated, so its detection would be a strong evidence of physics beyond the SM. We expect enhanced contributions that could be tested at the LHC in the near future.

P.25 **Cristina Schlesier (USA)**

Measuring Spin Precession in Muon g-2

The Standard Model prediction of the muon anomalous magnetic moment (aμ) has a greater than 3σ difference from the value measured by the BNL Muon g-2 Experiment (E821). The Fermilab Muon g-2 Experiment (E989) aims to measure aμ to a precision of 140 ppb - a fourfold improvement over the 540 ppb precision obtained in E821. The measurement of aμ is in part derived from the anomalous spin precession frequency (ωa). The ωa measurement procedure is outlined in this poster, which includes a description of the E989 electromagnetic calorimeters that provide a timing resolution of around 20 ps and an energy resolution of around 4% at 2 GeV. A description of the calorimeter readout electronics is also included.

P.26 **Pablo Serrano-Alfaro (Cuba)**

Determination of stacking ordering in disordered close packed structures from the pairwise correlation functions

It is shown how to reconstruct the stacking sequence from the pairwise correlation functions between layers in close packed structures. First, of theoretical interest, the analytical formulation and solution of the problem is presented when the exact pairwise correlation counts are known. In a second part, the practical problem is approached. A well-known simulated annealing procedure is developed to solve the problem using as initial guess approximate solutions from previous treatments such as εMSR [1] and Faults Models [2,3,4]. The robustness of the procedure is tested over synthetic data followed by experimental examples. [1] D. P. Varn, G. S. Canright, and J. P. Crutchfield. *Phys. Rev. B*, 66:174110-174113, 2002; [2] A. J. C. Wilson. *Proc. Roy. Soc. A*, 180:277-285, 1942; [3] B. E. Warren. X-Ray Diffraction. Addison-Wesley, New York, 1969; [4] E. Estevez-Rams, U. Welzel, A. Penton-Madrigal, and E. J. Mittemeijer. *Acta Cryst.*, A64:537-548, 2008.

P.27 **Roberto Silva González (Cuba)**

New insights of the Generalized Lifshits–Slezov–Wagner Distribution theory influenced by a second phase transformation

The particle (cluster) size distribution (PSD) function and the temporal evolution of the critical particle dimensions have been calculated assuming that the coarsening process is controlled by two mechanisms of mass transfer simultaneously operating: (i) the volume diffusion and (ii) the atomic exchange in the interface matrix-precipitate. The particularity of this new formulation is to predict the evolution of the above PSD function when a second phase transformation interferes with the Ostwald Ripening (OR) process. This new approach studies the influence of a second transformation on the particle size evolution when a common solute and two atomic transfer elementary mechanisms are considered. In a first approximation it is estimated that the second reaction only weakly interferes with the coarsening of precipitates. A significant modification of the LSW distribution is obtained in the above situation. This new perturbed formulation of the generalized LSW distribution function seems to fit better the experimental data in certain multicomponent systems of more than one phase.

P.28 **Kalisa Aneika Villafana (USA)**

High-Spin Gamma-ray Spectroscopy in $^{179,180}W$

High spin states of $^{179,180}W$ were produced via the 4n and 5n channels respectively in the ^{14}C + ^{170}Er reaction at beam energies of 68MeV and 75MeV. This experiment was performed at Florida State's John D. Fox Laboratory with three escape-suppressed germanium clovers and seven escape-suppressed single crystal germanium detectors in order to detect gamma rays. The experiment produced 852 million γ-γ coincidences and 82 million γ-γ-γ coincidences at 75MeV beam energy. Additionally, at 68MeV, there were 119 million γ-γ coincidences and 9.6 million γ-γ-γ coincidences. Analysis of this data is in progress using the Radware analysis package using both double (matrix) and triple (cube) formats [1]. The primary purpose of the experiment was to add to a systematic investigation of band crossing frequencies in heavy tungsten nuclei to observe the effect of seniority on pairing correlations [2]. Preliminary analysis is already revealing extensions to previously known structures [3,4] as well as new bands being observed. Moreover, preliminary calculations of band crossing frequencies have been made. These results will be presented and discussed. [1] D.C. Radford, *Nucl. Instrum. Methods Phys. Res. A* 361, 267 (1995); [2] S.L. Miller et al., to be published; [3] P.M. Walker et al., *Phys. Rev Lett*. 67, 4 (1991); [4] P.M. Walker et al., *Phys. Lett. B* 309, 17 (1993).

P.29 **Laura Olivia Villegas Olvera (México)**

Formation and evolution of SuperMassive Black Holes

The objective of this work is to analyze the processes of supermassive black holes (SMBH) formation, which can have masses greater than 10^6 Msun and these are in the center of the majority of the massive galaxies. As we know, one of the methods of forming a black hole is by stellar evolution, however the resulting mass is only a few tens of solar masses and the time of growth of this kind of black holes, to become a SMBH, would be greater than the age of the Universe. Formation and evolution is still an open problem. In this work, I will propose a model that includes turbulence in the dynamics of matter around the black hole, explaining the accretion process by numerical simulations.

P.30 **Pheona Williams (USA)**

Temperature-dependent Raman Spectroscopy of Topological Insulators

Topological insulators, materials whose bulk interior is insulating with a surface which contains conducting free electrons, are a leading new "quantum material". Their optical properties have shown interesting phenomena such as phonon confinement effects in Raman spectroscopy, saturable absorption for mode-locking applications and the existence of Dirac plasmons at terahertz frequencies. As the thickness of the sample decreases, more phonons are active which results in peak position shift and broadening of the Raman signal. Recently, Bi_2Se_3 and Sb_2Te_3 crystals in the temperature range between 5 K and 300 K were shown to have a characteristic temperature dependence of the phonon peak position and linewidth interpreted in terms of thermal expansion and three-phonon anharmonic decay. The objective of this work is to explore the temperature dependence of the phonon peak position and linewidths in new topological insulators crystals and thin films. To achieve this goal, we utilize temperature dependent Raman by exciting samples with 514 nm light for a spot size of ~ 1 um and collecting scattered polarized Raman signal of quintuple layers of thin films of Bi_2Se_3, Bi_2Te_2Se and bulk crystals in 4 different geometries. For thin films of 4-60 QL at temperatures, we systematically present the evolution of the H-mode (Se-Se lattice vibrations at the surface) for Bi_2Se_3 as a function of protective capping layer, temperature and excitation power and compare it against bulk crystals.

P.31 **Tiffany Nichols (USA)**

Map Usage in the Site Selection of the Laser Interferometer Gravitational-Wave Observatory (LIGO) Large-Scale Interferometers

My research explores the use of maps in identifying sites for placement of large-scale interferometers by LIGO and affiliated researchers involved in the site selection process which has been overlooked in research directed to the history of gravitational wave detection. Specifically, I seek to show that map scale, in this case predominately 7.5 minute topography maps, led to placement of the interferometers in unexpectedly noisy areas. I will rely on cognitive psychology theories related to perception of and understanding differences of scale between a map and the land. Although these topography maps provided the information to determine the flatness of the land, a highly sought after quality for the sites, these maps did not provide sufficient information concerning localized disturbances that would affect the ability of the interferometers to detect gravitational waves. These decisions necessitated engineering solutions that would stabilize the interferometer to avoid masking gravitational waves which deform the spacetime fabric on the order of 1 x 10^{-22}. Surprisingly, due to the unexpectedly noisy sites, the engineered solutions allowed for increases of sensitivity in the magnitude range of 1 x 10^{-22}, which resulted in the detection event on September 14, 2015.

P.32 **Homa Assadi (Canada)**

The Optical Properties of Biological Tissue on the Presence of Microbubbles

In this study, micrometer-sized (< 5μm) microbubbles (MBs) – a gas-core shell-encapsulated agent - were investigated as microcirculation optical contrast agents. Microbubbles produce a refractive index mismatch between the gas core and water media, which would potentially make MBs optically distinguishable from surrounding tissue. The working hypothesis of this study is that the microbubbles can be administrated into blood circulation as optical contrast agents for diffuse optical imaging (DOI) method enhancing light scattering in blood vessels. The effect of microbubbles on the optical properties of the biological phantom solution was quantitatively assessed. In this study, microbubbles were investigated as intravascular DOI contrast agents. Intralipid phantom solutions mixed with various concentrations of human blood (0.2% - 1.5%, 3%, 6%) were used to mimic both normal and abnormal skin tissues conditions. The microbubbles injection dose of 166μL/Kg enhanced the scattering contrast ~1.4 fold indicating a potential use of MBs as DOI optical contrast agents. These results presented a pilot study that indicated the differences in the tissue scattering properties after MBs injection in the spectral regions.

P.33 **Shaowei Li (USA)**

Single Molecule Mechanochemistry: Controlling the Hydrogen Dissociation by Scanning Tunneling Microscope

Traditionally, chemical reactions have been controlled by tuning the reaction conditions, such as temperature, electric field, light, or pressure. Using the Scanning Tunneling Microscope, we can visualize and control the dissociation of hydrogen molecule on Cu surface at single molecule level. Molecular hydrogen can be trapped between the STM tip and metal substrate at low temperature by Van der Waals force. The energy required for dissociation can be provided by the electron flow from STM tip to substrate. By varying the energy of incoming electron, the dissociation barrier can be measured in real space. We also investigate the dissociation barrier on top of single CO molecule and single Au adatom and have found that the CO molecule is working as a catalyst while Au atom is an anticatalyst. The dissociation barrier can also be controlled by tuning the tip-substrate separation: as we "squeeze" the trapped hydrogen molecule by decreasing the tip-substrate separation, the dissociation barrier decreases significantly. By "squeezing" the trapped molecule, the dissociation reaction can be induced even with energy of the tunneling electrons below 1 meV.

P.34 **Dena Monjazebi (Canada)**

Feasibility of Diagnostic Interstitial Ex-Vivo Mammary Autofluorescence Microendoscopy

Objective: This is a feasibility study to explores the ability of the Autofluorescence (AF) microendoscope to discriminate between cancer and normal tissue when inserted interstitially into the excised breast. Methods: After institutional approval, 5 women with breast cancer planned for curative mastectomy were recruited. Immediately after mastectomy, the breast specimen was taken to the pathology. A standard 14-gauge (BARD) biopsy trocar was inserted into the breast tumor to create a hollow passage into the cancer. A 550-micron outer diameter high resolution (6000 pixel) microendoscope (Polydiagnost, Germany) coupled to AF imaging was inserted and AF images were taken. The AF illumination wavelength range was 390 to 450 nm. A core needle tissue biopsy was taken. This was repeated into a normal tissue. The biggest obstacle was the inflow of blood into the working channel, however sufficient quality images could be obtained upon saline rinsing. Results and Discussion: The 5 patients had invasive ductal carcinoma. AF microendoscopy demonstrated 100% sensitivity and specificity to differentiate between the pathologically proven cancer and normal tissue. A green for normal and reddish image for malignancy could be clearly discriminated. We developed a reliable, feasible and safe biopsy coupled method to obtain AF images and correlative tissue biopsies. An AF microendoscopy coupled with image guided biopsy could potentially reduce the number of biopsies that the patients undergo.

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