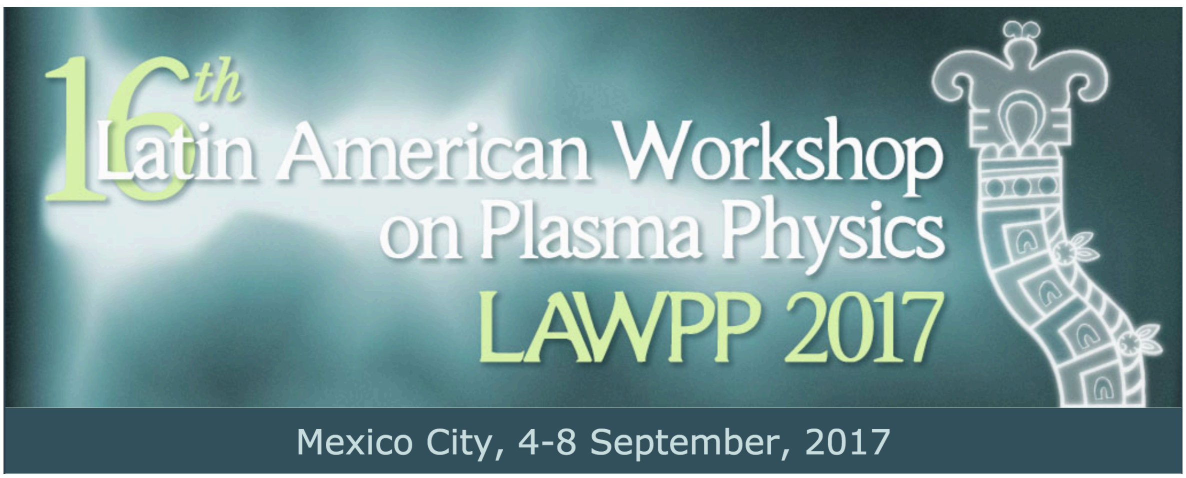
16th Latin American Workshop on Plasma Physics
LAWPP 2017
Universidad Nacional Autónoma de México
Mexico City

4-8 September



Book of Abstracts

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Talks at the Instituto de Ciencias Nucleares

	Sunday 3	Monday 4	Tiuesday 5	Wednesday 6	Thursday 7	Friday 8
9:00-9:20		Registration-Opening				
9:20-9:40			Lazerson PT3	Martin PT5	Tu PT7	Verboncoeur PT10
9:40-10:00						
10:00-10:20			Nieves-Chinchilla PT4			
10:20-10:40		Takeiri PT1		Gekelman PT6	Andruczyk PT8	Caldas PT11
10:40-11:00						
11:00-11:30		Cofee Break				
11:30-11:50			Blanco IT4	Delgado IT6		Rodríguez Prieto IT11
11:50-12:10		Gonzalez PT2			del-Castillo PT9	
12:10-12:30						
12:30-12:50			Torreblanca IT5	Morales IT7		Soto L. IT12
12:50-13:10		Golla IT1	Esquivel O5	Bellintani O6	Grondona IT10	Corona O11
13:10-15:00		Lunch				
15:00-15:20		Lara IT2		Martinell IT8		Severo IT13
15:20-15:40			Gekelman S1*		Verboncoeur S2*	
15:40-16:00		de Gouveia		Bilbao IT9		Kryukov O12
16:00-16:20		Dal Pino IT3				Gutiérrez O13
16:20-16:40		Cofee Break		Cofee Break		García-Perciante O14
16:40-17:00		Raga O1	Poster Session 1**	Salazar O7	Poster Session 2**	Cofee Break
17:00-17:20	Registration at Radisson Hotel	Soto R. O2		Muñóz O8		
17:20-17:40		Niembro O3		Guzmán O9		Summary
17:40-18:00		Coto-Vilches O4		Páez O10		

Talks at the Instituto de Investigaciones en Materiales

	Sunday 3	Monday 4	Tiuesday 5	Wednesday 6	Thursday 7	Friday 8
9:00-9:20						
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12:10-12:30						
12:30-12:50						
12:50-13:10						
13:10-15:00		Lunch				
15:00-15:20		Muhl IIM1		Pacheco M. OIM 5		Ozono OIM13
15:20-15:40			Gekelman S1*	Ramírez OIM6	Verboncoeur S2*	Villagrán OIM14
15:40-16:00		Torreblanca		Rodríguez Prieto OIM7		Barillas OIM15
16:00-16:20		IIM2		Soria OIM8		Rodríguez-Rojas OIM16
16:20-16:40		Coffe Break		Cofee Break		Borjas OIM17
16:40-17:00		Leal OIM1	Poster Session 1**	Zendejo OIM9	Poster Session 2**	Cofee Break
17:00-17:20	Registration at Radisson Hotel	Grondona OIM2		Rojas-Pérez OIM10		
17:20-17:40		Ramos OIM3		Oseguera OIM11		Summary
17:40-18:00		Pacheco J. OIM4		Robledo OIM12		

*** Graef Fernández Auditorium, at the Amoxcalli building, Facultad de Ciencias**

**** Lobby of the Amoxcalli building, Facultad de Ciencias**

For more information please check the workshop webpage
http://www.nucleares.unam.mx/LAWPP2017

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Graphic Design: Aline Guevara, Instituto de Ciencias Nucleares, UNAM

Monday 4 September
Marcos Moshinsky Auditorium, ICN

9:00 – 10:00 **Registration and Welcome**

10:00 -11:00 **Deuterium Experiment in Large Helical Device towards Steady-State Helical Fusion Reactor (PT1)**
Yasuhiko Takeiri, National Institute of Fusion Science, Japan

11:00- 11:30 **Break**

11:30-12:30 **Magnetic reconnection at the Earth's magnetosphere using the magnetosphere multiscale mission (MMS) (PT2)**
Walter González, Instituto Nacional de Pesquisas Espaciais, Brazil

12:30-13:10 **Non-linear Plasma Processes in Space Plasma Environments (IT1)**
Thejappa Golla, University of Maryland and NASA, USA

13:10-15:00 **Lunch**

15:00-15:40 **Dynamics of Coronal Mass Ejections in the interplanetary Medium in the vicinity of the Sun (IT2)**
Alejandro Lara, Instituto de Geofísica, UNAM

15:40-16:20 **Magnetic reconnection and Particle Acceleration in Astrophysical Sources and Environments (IT3)**
Elisabete M. de Gouveia Dal Pino, Universidade de São Paulo, Brazil

16:20-16:40 **Break**

16:40-17:00 **Photoionized jets from massive young stars (O1)**
Alejandro Raga, Instituto de Ciencias Nucleare, UNAM, Mexico

17:00-17:20 **Detection of drift-mirror instability and High beta plasma observations in Earth's inner Magnetosphere (O2)**
Rualdo Soto, New Jersey Institute of Technology, US

17:20-17:40 **The seesaw space, a vector space to identify and characterize large-scale structures at 1 AU (O3)**
Tatiana Niembro Hernández, Instituto de Geofísica, UNAM

17:40-18:00 **Vacuum magnetic flux surface measurements on the SCR-1 Stellarator** (O4)
F. Coto-Vílchez, Instituto Tecnológico de Costa Rica, Costa Rica

Monday 4 September
Auditorium of the
Instituto de Investigaciones en Materiales

15:00-15:40	**The effect of the geometry of the magnetic field on the trajectory of the secondary electrons and the shape of the erosion race track in a magnetron cathode (IIM1)** Stephen Muhl, Instituto de investigaciones en Materiales, UNAM, Mexico
15:40-16:20	**Overview of Plasma Processing on the Semiconductor Industry (IIM2)** Humberto Torreblanca, General Atomics, USA
16:20-16:40	**Break**
16:40-17:00	**Non-thermal atmospheric-pressure plasma activation of herbal seeds indicating the acceleration of the plant's germination period (OIM1)** Edbertho Leal-Quiros, *California State University at Fresno, USA*
17:00-17:20	**Application of a Three-electrode Plasma Reactor for CO Treatment (OIM2)** Diana Grondona, Universidad de Buenos Aires, Argentina
17:20-17:40	**Characterization of PG-QRO-1 Intermediate Energy Deuterium Plasmas (OIM3)** Gonzalo Ramos-López, CICATA, Instituto Politécnico Nacional-Querétaro, Mexico
17:40-18:00	**Warm Plasma Torch for Hydrocarbon Reforming (OIM4)** Joel O. Pacheco, Instituto Nacional de Investigaciones Nucleares, Mexico

Tuesday 5 September
Marcos Moshinsky Auditorium, ICN

9:00 – 10:00	**Review on the Wendelstein 7X (PT3)** Samuel Lazerson, Princeton Plasma Physics Laboratory, USA
10:00 -11:00	**Theoretical Analytical Flux-rope model (PT4)** Teresa Nieves-Chinchilla, Catholic University of America, USA
11:00- 11:30	**Break**
11:30-12:10	**Interplanetary Shocks (IT4)** Xochitl Blanco, Instituto de Geofísica, UNAM, Mexico
12:10-12:50	**Helicon Antenna Heating and its Technical Challenges at the DIII-D Tokamak (IT5)** Humberto Torreblanca, General Atomics, USA
12:50-13:10	**Using the anisotropy of observational maps to study interstellar turbulence (O5)** Alejandro Esquivel, Instituto de Ciencias Nucleares, UNAM, Mexico
13:10-15:00	**Lunch**

Amoxcalli Building, Facultad de Ciencias

15:00-16:00	**Visualization of Alfén Shear Waves in the LAPD experiment (S1)** Walter Gekelman, University of California at Los Angeles, USA
16:00-18:00	Poster Session 1

Wednesday 6 September
Marcos Moshinsky Auditorium, ICN

9:00 – 10:00 **The Reversed Field Pinch international fusion programme: status and perspectives (PT5)**
Piero Martin, Università degli Studi di Padua, Italy

10:00 -11:00 **Ohms law and the collision of magnetic flux ropes (PT6)**
Walter Gekelman, University of California at Los Angeles, USA

11:00- 11:30 **Break**

11:30-12:10 **Impurities in the core of magnetically confined fusion (MCF) plasma: Transport, stability and diagnostic challenges (IT6)**
Luis Felipe Delgado, Princeton Plasma Physics Laboratory, USA

12:10-12:50 **Avalanches in Magnetized Plasmas (IT7)**
George Morales, University of California at Los Angeles, USA

12:50-13:10 **Optical Design of Wide Field and High Resolution Objectives for Spectroscopy Measurements in the TCABR Tokamak (O6)**
Valdemar Bellintani, Facudade de Tecnologia de São Paulo FATEC SP, Brazil

13:10-15:00 **Lunch**

15:00-15:40 **Equilibrium, stability and transport studies in the TJ-II Heliac (IT8)**
Julio Martinell, Instituto de Ciencias Nucleare, UNAM, Mexico

15:40-16:20 **Measurements of metallic gas properties by means of an exploding wire experiment (IT9)**
Luis Bilbao, Universidad de Buenos Aires, Argentina

16:20-16:40 **Break**

16:40-17:00 **Modeling of hybrid fusión/fission systems for development of advanced nuclear fuel cycles (O7)**
J. Humberto Salazar, CICATA, Instituto Politécnico Nacional-Querétaro, Mexico

17:00-17:20 **Evolution of fractality in magnetic clouds (O8)**
Victor Muñoz, Universidad de Chile, Chile

17:20-17:40 **Design, methods, tests, applications to solar physics and potential new applications of a new ideal and resistive MHD code (O9)**
Francisco S. Guzmán, Universidad Michoacana de San Nicolás de Hidalgo, Mexico

17:40-18:00 **Kelvin-Helmholtz instability at sheath-solar winds interface (O10)**
A. Páez, Universidade de São Paulo, Brazil

Wednesday 6 September
Auditorium of the
Instituto de Investigaciones en Materiales

15:00-15:20 **Multilayer graphene growth assisted by sulfur using the arc discharge method at ambient conditions (OIM5)**
Marquidia Pacheco, Instituto Nacional de Investigaciones Nucleares, Mexico

15:20-15:40 **Surface modification of graphene nanoplateletes (GNPs) with radiofrequency plasma or high voltage for the preparation of polypropylene/GNPs nanocomposites (OIM6)**
D.M. Ramírez-López, Universidad Autónoma de Coahuila, Mexico

15:40-16:00 **Hydrodynamic effect of discharge of dielectric barrier in the flow of air around an airfoil NACA 0018 (OIM7)**
David Alamilla-Flores, CICATA, Instituto Politécnico Nacional-Querétaro, Mexico

16:00-16:20 **Synthesis of carbon nanostructures using plasma, study of electrical parameters and their influence on nanostructures formation (OIM8)**
G. Soria, CONACYT- Centro de Investigación en Química Aplicada, Mexico

16:20-16:40 **Break**

16:40-17:00 **Surface modification of graphene nanoparticles with ethylene plasma in a rotary plasma reactor for the preparation of PE/G nanocomposites (OIM9)**
R.A. Zendejo Covarrubias, Universidad Autónoma de Coahuila, Mexico

17:00-17:20 **CFD Modeling of Plasma Gasification Reactor for Municipal Solid Waste (OIM10)**
Francisco Rojas-Pérez, Instituto Tecnológico de Costa Rica, Costa Rica

17:20-17:40 **TiAlN films produced by HiPIMS for industrial tribo-mechanical applications (OIM11)**
Joaquín Oseguera, Instituto Tecnológico de Estudios Superiores de Monterrey, Mexico

17:40-18:00 **Signal enhancement in laser-induced breakdown spectroscopy using gated high-voltage pulses (OIM12)**
Arturo Robledo, Universidad Autónoma Metropolitana-Azcapotzalco, Mexico

Thursday 7 September
Marcos Moshinsky Auditorium, ICN

9:00 – 10:00 **Plasma-catalysis: a green technology for environmental and energy applications (PT7)**
Xin Tu, University of Liverpool, United Kingdom

10:00 -11:00 **Overview of the HIDRA Project (Hybrid Illinois Device for Research and Applications)(PT8)**
Daniel Andruczyk, University of Illinois at Urbana Champaigne, USA

11:00- 11:30 **Break**

11:30-12:30 **Runaway Electrons in Magnetically Confined Fusion Plasmas (PT9)**
Diego del-Castillo-Negrete, Oak Ridge National Laboratory, USA

12:30-13:10 **Experimental and theoretical study of a contracted glow plasma jet discharge (IT10)**
Diana Grondona, Universidad de Buenos Aires, Argentina

13:10-15:00 **Lunch**

Amoxcalli Building, Facultad de Ciencias

15:00-16:00 **Plasma Physics Computer Laboratory (S2)**
John Verboncoeur, Michigan State Uniersty, USA

16:00-18:00 Poster Session 2

Friday 8 September

9:00 – 10:00	**High Voltage Breakdown: from Surface Multipactor to Ionization Discharge (PT10)** John Verboncoeur, Michigan State University, USA
10:00 -11:00	**Simplectic Maps for Diverted Plasmas (PT11)** Iberê Caldas, Universidade de São Paulo, Brazil
11:00- 11:30	**Break**
11:30-12:10	**Morphology of the expansion of a plasma created by means of exploding wires (IT11)** G. Rodríguez Prieto, Universidad de Castilla-La Mancha, Spain
12:10-12:50	**Small Dense Pulsed Plasma Discharges Program at the Chilean Nuclear Energy Commission Basic Research and Applications to Fusion, Materials and Biology (IT12)** Leopoldo Soto, Comisión Chilena de Energía Nuclear, Chile
12:50-13:10	**ISTTOK Real Time Magnetic Multiple input-Multiple output Control (O11)** Doménica Corona, Instituto Superior Técnico, Portugal
13:10-15:00	**Lunch**
15:00-15:40	**Review of Plasma Rotation Results Obtained in TCABR Tokamak (IT13)** J.H.F. Severo, Universidade de São Paulo, Brazil
15:40-16:00	**Drift wave transport in a plasma with a thermal distribution of Larmor radii (O12)** Nikolai Kryukov, Instituto de Ciencias Nucleares, UNAM, Mexico
16:00-16:20	**Confinement improvement during edge plasma biasing in the TJ-II stellarator (O13)** César Gutiérrez, Instituto Nacional de Investigaciones Nucleares, Mexico
16:20-16:40	**Fluctuations dynamics for a relativistic single component plasma in the electrostatic case (O14)** Ana Laura García-Perciante, Universidad Autónoma Metropolitana-Cuajimalpa
16:40-17:00	**Break**
17:00-18:00	**Summary**

Friday 8 September
Auditorium of the
Instituto de Investigaciones en Materiales

15:00-15:20 **Using Insulation of Porcelain for Glow Discharge Plasma of the DC Planar Reactor (OIM13)**
Edson Moriyoshi Ozono, Faculty of Technology of São Paulo, Brazil

15:20-15:40 **Study of laser ablation of levitated water droplets (OIM14)**
Mayo Villagrán, Centro de Ciencia Aplicada y Tecnología Avanzada, UNAM, Mexico

15:40-16:00 **Hydroxyapatite coatings on polymers using a Low Energy Plasma Spray (LEPS) system (OIM15)**
Laura Barillas, Instituto Tecnológico de Costa Rica, Costa Rica

16:00-16:20 **Low-Temperature Plasma Irradiation to Improve Germination and Growth in Seeds of Coriandrum sativum, Lycopersicon lycopersicum, Phaseolus vulgaris and Raphanus Sativus L (OIM16)**
J. Rodríguez-Rojas, Instituto Tecnológico de Costa Rica, Costa Rica 16:00-16:20

16:20-16:40 **Superficially Modification in Graphite via cold plasma treatment of ethylene for the development of thermally conductive polymer composites based on High Density Polyethylene (OIM17)**
Javier Borjas Ramos, Centro de Investigación en Química Aplicada, Mexico

16:40-17:00 **Break**

17:00-18:00 **Summary at the Marcos Moshinsky Auditorium, ICN**

Poster Session 1
Lobby of the Amoxcalli Building
Facultad de Ciencias

P1-1 **Moved to O5**

P1-2 **Cancelled**

P1-2a **The Morphology and Directionality of Intense Birkeland Currents Surrounding Earth from Global Imagery Satellite and GPS Data**
Anthony Peratt, Los Alamos National Laboratory (ret.), USA

P1-3 **Force-free fields in the solar corona and the identification of solar are sites**
Juan Burke, Instituto de Ciencias Nucleares, UNAM, Mexico

P1-4 **Microwave Brightness Enhancements Inside Coronal Holes**
César Aveleyra, Instituto de Geofísica, UNAM, Mexico

P1-5 **The shadow of the Sun view by HAWC**
Paulina Colín, Instituto de Geofísica, UNAM, Mexico

P1-6 **A Thermodynamic Approach of the ICMEs evolution of speed, travel time and temperature**
Héctor Durand-Manterola, Instituto de Geofísica, UNAM, Mexico

P1-7 **Automatic identification of large-scale structures associated with the observations of STEREO spacecraft**
Juan Carlos González Marín, Instituto de Geofísica, UNAM, Mexico

P1-8 ***Tomographic reconstruction of the ionospheric plasma over LISNʃ Numerical simulations and data fusion***
Meyer Merino, Universidad Peruana de Ciencias Aplicadas, Perú

P1-9 **Numerical model of jet formation in the solar atmosphere**
J.J. González-Avilés, Universidad Michoacana de San Nicolás de Hidalgo, Mexico

P1-10 **Studying SEP events using STEREO Spacecraft**
Luis Preisser, Instituto de Geofísica, UNAM, Mexico

P1-11 **Coherent π pulse emitted by a dense relativistic cold electron beam**
Johny Alejandro Arteaga Guarumo, Universidade Federal Fluminense, Brazil

P1-12 **Photodetachment of negative ions in a swarm experiment: Experiment and simulations.**
Jaime de Urquijo, Instituto de Ciencias Físicas, UNAM, Mexico

P1-13 **Electron drift velocity and density-reduced effective ionization coefficient in pure chlorine**
Olmo González-Magaña, Instituto de Ciencias Físicas, UNAM, mexico

P1-14 **Non-Maxwellian distributions and their foundation on non-extensive statistical physics**
J. Julio E. Herrera-Velázquez, Instituto de Ciencias Nucleares, UNAM, Mexico

P1-15 **Moved to oral O12**

P1-16 **Kinetic foundations of relativistic magnetohydrodynamics revisited**
A. R. Sagaceta-Mejía, Universidad Iberoamericana, Mexico

P1-17 **Formation of recombining plasma in divergent magnetic field on the linear divertor simulat TPD-Sheet IV (O7)**
Toshikio Takimoto, Tokai University, Japan

P1-18 **Complex networks study of the Extended Hasegawa-Wakatani model**
Maricarmen Castro, Universidad de Chile, Chile

P1-19 **The versatile high field ultra-low aspect ratio tokamak (HF-ULART) experiment**
Celso Ribeiro, Independent Consultant, Brazil

P1-20 **Dynamics of the stationary and non-stationary regime observed in Spherical Tokamaks with Plasma Center Column**
L. G. Lampugnani, Instituto Balseiro, Argentina

P1-21 **Improvements of PXI-Based ECRH Control System on SCR-1 Stellarator**
J. Asenjo, Instituto Tecnológico de Costa Rica, Costa Rica

P1-22 **Moved to O4**

P1-23 **Microwave heating scenarios using a full wave code on SCR-1 Stellarator**
R. Solano-Piedra, Instituto Tecnológico de Costa Rica, Costa Rica

Poster Session 2
Lobby of the Amoxcalli Building
Facultad de Ciencias

P2-1 **Moved to oral OIM7**

P2-2 **Study of the atmospheric-pressure discharge in air**
Fermín Castillo, Instituto de Ciencias Físicas, UNAM, Mexico

P2-3 **Wettability behaviour of polyethylene glycol/polyhydroxybutyrate composites treated by atmospheric plasma**
Maraolina Domínguez-Díaz, Instituto de Ciencias Físicas, UNAM, Mexico

P2-4 **Moved to OIM16**

P2-5 **Moved to OIM10**

P2-6 **Análisis and performance of a plasma reactor with the influence of addition of air/coal rate**
A. Díaz, Instituto Nacional de Investigaciones Nucleares, Mexico

P2-7 **Synthesis of Boron-doped carbon nanotubes with DC electric arc discharge**
P. Vilchis, Instituto Nacional de Investigaciones Nucleares y Universidad Autónoma del Estado de México, Mexico

P2-8 **Electrical discharge for the degradation of textile dyes in a continuous flow of water waste**
Aarón Gómez-Díaz, Universidad Autónoma del Estado de México, Mexico

P2-9 **Optimization of the dyes degradation azo Acid Black 52, triazo Acid Black 210 and its mixture by corona discharge**
César Torres, Universidad Autónoma del Estado de Morelos, Mexico

P2-10 **Pulsed corona plasma in glycerin for fuel gas generation**
Viacheslav Plotnikov, University of California at Merced, USA

P2-11 **Effectiveness Comparison Between Oxygen and Argon Low Pressure RF Plasma Sterilization, Using a Custom Antenna**
J. Sanchez-Castro, Instituto Tecnológico de Costa Rica, Costa Rica

P2-12 **Quantification of the atmospheric cold plasma treatment effect on TiO_2 particle settling dynamics**
Michelle Tirado-Guerrero, CICATA, Instituto Politécnico Nacional-Querétaro, Mexico

P2-13 **Design and construction of a rotary cold plasma reactor for powder and nanoparticles functionalization and superficial chemically modification**
Roberto Zúñiga Oviedo, Instituto Tecnológico de Pachuca, Mexico

P2-14 **Simulation of a Hyperbolic Field Energy Analyzer**
Angel González-Lizardo, Polythechnic University of Puerto Rico, Puerto Rico

P2-15 **Análisis de la densidad de los iones positivos y electronegatividad en el plasma del CO y CO2 en una descarga DC mediante una sonda de Langmiur**
Farook Bashir Yousif, Universidad Autónoma del Estado de Morelos, Mexico

P2-16 **Characterization of SiC and Al_2O_3 Ceramics Exposed to Nitrogen Ions from Inverse-Z Pinch Plasma Discharge**
Mauricio A. Algatti, FEG-DFQ-UNESP, Brazil

P2-17 **Cancelled**

P2-18 **Moved to oral OIM3**

P2-19 **Moved to oral OIM7**

P2-20 **Development of a Coaxial-DBD Fluidized-Bed Plasma Reactor Monitored with Laser Light Scattering Signals**
E. Augusto G-Guerrero, CICATA, Instituto Politécnico Nacional-Querétaro, Mexico

P2-21 **Cancelled**

P2-22 **Espectroscopia de Plasma Inducido por Láser mejorado con Nano-partículas (NE-LIBS).**
J.D. Idárraga, Universidad Tecnológica de Pereira, Colombia

P2-23 **Simultaneous study of cavitation bubbles produced by laser ablation by photoacoustic and laser-beam-transmission-probe techniques**

D. Mustri-Trejo, Universidad Veracruzana, Mexico

P2-24 Study of diglyme plasmas by mass spectrometry
Antonio Renato Bigansolli, DEQ-IT-UFRRJ, Brazil

P2-25 Carbon nanostrucutures deposition on surfaces treated by warm plasma processes
Ricardo Valdivia-Barrientos, Instituto Nacional de Investigaciones Nucleares, Mexico

P2-26 Cancelled

Post-Deadline Posters
Lobby of the Amoxcalli Building
Facultad de Ciencias

PD-1 **Optical and electrical characterization of an Ar discharge, together with an electrode of BN.**
Esteban Pardo L., Universidad Autónoma del Estado de Morelos, Mexico

PD-2 **Three dimensionalself-modulated beamdynamics of a non-laminar,ultra relativistic beam in a non-relativistic cold plasma**
Tamina Akhter, INFN-Sezione di Napoli

PD-3 **Study of the Interaction of an O_2 Plasma with the Ti_6Al_4V Alloy**
Mauricio Isoldi, LSI-EPUSP, University of São Paulo, SP, Brazil

PD-4 **Moved to OIM13**

PD-5 **Study of the Interaction of an O_2 Plasma with the Ti_6Al_4V Alloy**
Itzel Reyes, Facultad de Química, UNAM, Mexico

PD-6 **Comparing Langmuir Probe I-V Characteristics of Different Probe Radius in Maxwellian Ionospheric Plasma**
Shankar Bhattarai, *Patan Multiple Campus, Tribhuvan University*, *Lalitpur, Nepal*

PD-7 **Measurement and modeling of DC currents collected by a RF biased electrode in ALINE**
Naharai Ramírez, *University of Lorraine, France*

PD-8 **Micro plasma based surface modification of ZnO-Epoxy-Graphene flexible thin films**
Sanjee Kumar, *California State University at Fresno, USA*

PD-9 **A study on axisymmetric toroidal Taylor states**
Alejandro Aviña, *Instituto de Ciencias Nucleares, UNAM,* Mexico

PD-10 **Review of the dynamics of plasma expansion in pulsed laser ablation plumes**
Antonio Paz*, Universidad Autónoma de Nuevo León, Mexico*

PD-11 **Burn control of a fusion reactor using a fuzzy logic system**
Sair García, *Instituto de Ciencias Nucleares, UNAM, México*

Special
Talks

Visualization of Alfén Shear Waves in the LAPD experiment

Walter Gekelman
Department of Physics and Astronomy
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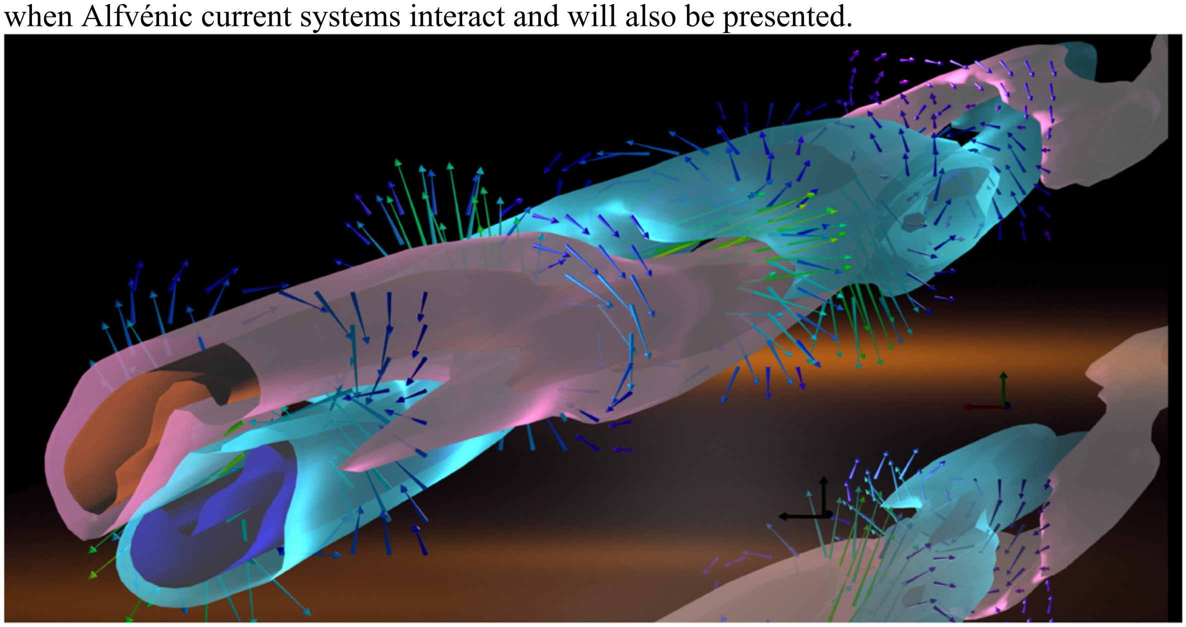
Plasma or ionized matter behaves differently than a gas. Because of long-range electrical forces the medium supports a variety of waves. These allow communication from one part of the plasma to another without any direct collisions between the particles. An enormous variety of waves in magnetized plasmas exist, far too many to discuss in a single seminar. Instead we will focus on a fundamental mode, the shear Alfvén wave. Alfvén waves are important in a wide variety of physical environments. They play a central role in the stability of magnetic confinement devices, give rise to aurora formation in planets, and are thought to contribute to heating and ion acceleration in the solar corona. Shear waves of finite transverse scale have electric fields parallel to the local background magnetic field, which is key to understanding current systems, and they can also cause particle acceleration over considerable distances in interstellar space. Sometimes they take the exotic form of magnetic ropes. They are proposed to form turbulent cascades and generate structures in astrophysical situations. Shear waves of various forms have been a topic of experimental research for more than twenty years in the Large Plasma Device (LAPD) at UCLA. We will show how the waves can be launched using antennas or as the result of secondary processes. The three-dimensional currents associated with the waves have been mapped and the ion motion, which closes the currents across the magnetic field observed with laser induced fluorescence. The propagation in inhomogeneous magnetic fields and density gradients has been studied as well as effects of collisions and reflections from boundaries. Heating of the plasma electrons and ions has also been observed. They are also produced by a exploding laser produced plasma in a background magnetoplasma. Magnetic field line reconnection, the conversion of magnetic energy to other forms has been observed when Alfvénic current systems interact and will also be presented.



The measured current (colored surfaces) and magnetic field of a Shear Alfvén wave.

Plasma Physics Computer Laboratory

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The Plasma Theory and Simulation Group (PTSG) at Michigan State University (formerly at the University of California - Berkeley) has developed a set of general purpose plasma codes. This includes particle-in-cell (PIC) codes in multiple dimensions and geometries, designed for basic science and a broad range of applications. We will provide an introduction to how the codes work, and a real time tutorial applying them to textbook problems. The code suite, including source code, is available from the PTSG web site: https://ptsg.egr.msu.edu/.

[†]Research supported by many sources over 3 decades, including AFOSR, DOE, NSF, ONR, Michigan State University, and many others.

Plenary
Talks

Deuterium Experiment in Large Helical Device towards Steady-State Helical Fusion Reactor

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Large Helical Device (LHD) is one of the world-largest superconducting helical system fusion-experiment devices, the plasma major and minor radii of which are around 3.6 m and 0.6 m, respectively. Since the start of experiments in 1998, LHD has demonstrated its inherent advantage for steady-state operation. The LHD project has been developed aiming at achievement of the reactor-relevant plasma conditions and the exploration of related plasma physics in helical magnetic configurations. Until now, high-performance plasmas have been achieved, individually, such as the ion temperature of 8.1 keV, the electron temperature above 10 keV, the volume-averaged beta value of 5.1 %, and steady-state plasma discharge for 48 min with $n_e \sim 1.2\times10^{19}$ m^{-3} and $T \sim 2$ keV [1].

Based on the leading development of helical plasma research, LHD has progressed to the advanced stage, that is, the deuterium experiment starting in March 2017. It is expected that plasma parameters should be extended towards more reactor-relevant regime, and the related physics research are allowed in such extended regime. As an initial result in the deuterium experiment, the ion temperature above 9 keV has been achieved, approaching closely to the fusion-relevant target value (10 keV), which has exceeded the LHD's own record of 8.1 keV achieved in the hydrogen experiment phase [2]. For establishing a firm basis for designing a steady-state helical fusion reactor, wide-ranging research has been intensively conducted such as on isotope effect, confinement capability of energetic particles through direct measurement of fusion-produced neutrons, plasma-material interactions, and others.

The LHD project is overviewed highlighting recent results obtained in the deuterium experiment, and perspectives towards steady-state fusion reactor is also mentioned.

Acknowledgements:
The author deeply acknowledges all the domestic and international collaborators for their great contributions on the LHD project.

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Magnetic reconnection at the Earth's magnetosphere using the magnetosphere multiscale mission (MMS)

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The Magnetospheric Multiscale (MMS) of NASA consisting of four spacecraft was launched on March 12, 2015 to investigate magnetic reconnection in the boundary regions of the Earth's magnetosphere, particularly along its dayside boundary with the solar wind and the neutral sheet in the magnetic tail. The most important objective of this mission was to conduct definitive observations to determine what causes magnetic field lines to reconnect in a collisionless plasma. The significance of the mission results is expected to extend far beyond the Earth's magnetosphere because reconnection is known to occur in interplanetary space and in the solar corona where it is responsible for solar flares and the disconnection events known as coronal mass ejections. Active research is also being conducted on reconnection in the laboratory and it is also proposed as the cause of numerous phenomena throughout the universe such as comet-tail disconnection events, magnetar flares, supernova ejections, and dynamics of neutron-star accretion disks. The MMS mission design is focused on answering specific questions about reconnection at the Earth's magnetosphere. The prime focus of the mission is on determining the kinetic processes occurring in the electron diffusion region that are responsible for reconnection and that determine how it is initiated.

In particular, I will present results on electron flow jets observed by MMS during the crossing of an ion diffusion region of a magnetopause reconnection event. An electron-scale current layer, originating from X-line and extending in both outflow directions, is identified on the magnetospheric side of the ion diffusion region. This electron-scale current layer consists of a perpendicular current dominating at its center and field-aligned currents mainly in the boundary regions. On the magnetospheric side of this layer, the inflowing electrons are streaming towards the X-line along the magnetic field while, on the magnetosheath side, the outflowing electrons are ejected away from the X-line. This field-aligned electron flow system in the current layer and the inflowing electrons on the magnetosheath boundary of the ion diffusion region constitute an integrated Hall current system and results in a seriously distorted Hall quadrupolar structure. Widths of the two quadrants adjacent to magnetosphere are electron-scale while the rest two quadrants on the magnetosheath side are ion-scale. The electron-scale current layer near the X-line was thinning while the MMS spacecraft crossed it. The energy dissipation and accumulation was simultaneously occurring in the thinning current layer.

PT3

Review of the Wendelstein 7-X experiment[1]

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In this talk, an overview of stellarator physics as it applies to the Wendelstein 7-X (W7-X) device is presented. The W7-X stellarator was completed in March of 2016 and represents the largest optimized device in the HELIAS line of magnetic confinement devices. The goals of this device are to demonstrate tokamak-like levels of energy confinement, stability at high plasma beta, operation of an island divertor, and pulse lengths of up to 30 minutes which achieve a high level of plasma performance. While classical stellarators have suffered from poor neoclassical particle confinement, the W7-X device utilizes 70 superconducting coils to produce magnetic flux surfaces numerically optimized for improved neoclassical confinement. Stellarators do not require current drive for confinement, unlike tokamaks, allowing access to steady state scenarios without the possibility of disruptions. Key to achieving the goal of a high beta 30 minute discharge are the heating and particle exhaust systems on W7-X. A steady state ECRH system capable of up to 10 MW continuous power injection is supplemented by two 4 MW neutral beam injectors and one MW of ICHR heating. A m/n=5/5 island chain at the plasma edge, designed to intersect divertor plates, provides both high-heat flux handling and edge pumping of the 30 m^3 plasma. This talk will present analysis of the first commissioning campaign OP1.1 in which a limiter was installed in the device. This 10 week campaign consisted in over 2000 discharges achieving core electron temperatures of 8 keV and ion temperatures of 2 keV using only 4 MW of ECRH heating. This was achieved at densities in the low to mid 1019 m3 range, producing confinement times in the 100-150 ms range (as predicted). Preparation and status of the current divertor commissioning campaign (OP1.2a) will also be discussed.

[1]This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.
[2]On behalf of the W7-X Team.

PT4

Theoretical Analytical Flux-rope model

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In this paper is presented an elliptic-cylindrical analytical flux-rope model, which establishes the first level of complexity above that of a circular-cylindrical geometry. The framework of this series of models was established by Nieves-Chinchilla et al. 2016 with the circular-cylindrical analytical flux rope model and under the concept developed by Hidalgo et al. 2002. The model attempts to describe the magnetic flux rope topology with distorted cross-section as a possible consequence of the interaction with the solar wind. In this model, the flux rope is completely described in the non-orthogonal geometry. The Maxwell equations are solved using tensor calculus consistently with the geometry chosen, invariance along the axial direction, and with the assumption of no radial current density.

The model is generalized in terms of the radial dependence of the poloidal current density component and axial current density component. The misalignment between current density and magnetic field is studied in detail for the individual cases of two different pairs of indices for the axial and poloidal current density components. This theoretical analysis provides a map of the force distribution inside of the flux-rope.

For reconstruction of the heliophysics flux-ropes, the circular-cylindrical reconstruction technique has been adapted to the new geometry and applied to *in situ* ICMEs with a flux-rope entrained and tested with cases with clear *in situ* signatures of distortion. The model adds a piece in the puzzle of the physical-analytical representation of these magnetic structures that should be evaluated with the ultimate goal of reconciling in-situ reconstructions with imaging 3D remote sensing CME reconstructions. Other effects such as axial curvature and/or expansion could be incorporated in the future to fully understand the magnetic structure. Finally, the mathematical formulation of this model paves the way to the next model: an analytical toroidal flux rope analytical model.

PT5

The Reversed Field Pinch international fusion programme: status and perspectives

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The Reversed Field Pinch (RFP) configuration belongs to the class of toroidal pinches and is studied as an alternative to the tokamak and the stellarator for the magnetic confinement of plasmas of thermonuclear interest.

As the tokamak, the RFP carries toroidal plasma current and is confined by an equilibrium magnetic field whose main components are toroidal and poloidal. Different from the tokamak, they are of comparable amplitude. Therefore, the RFP confines the same plasma current with an average toroidal field, which is a factor of ten smaller than in a tokamak. Moreover, the magnetic field at the coils is very small, thus leading to high engineering beta and to low stress in the coils. The toroidal field produced by external coils is indeed small, of the order of some mT for MA plasmas, since the field is mainly produced, through a self-organization process, by currents flowing in the plasma.

This talk will review the recent scientific achievements of the international RFP program, which is focussed on three main goals: exploring the fusion potential of the RFP magnetic configuration, contributing to the solution of key science and technology problems in the roadmap to ITER, and advancing basic plasma science, in particular in magnetically self-organized systems.

PT6

Ohms law and the collision of magnetic flux ropes

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Magnetic flux ropes are bundles of twisted magnetic fields and their associated current. They are common on the surface of the sun (and presumably all other stars) and are observed to have a large range of sizes and lifetimes. They can become unstable and resulting in coronal mass ejections that can travel to earth and indeed, have been observed by satellites. Single and multiple flux ropes have been reproducibly generated in the LArge plasma device (LAPD) at UCLA. Using a series of novel diagnostics the following key quantities, $\vec{B}, V_p, \vec{u}, n, T_e$ ($\vec{u}$ is the plasma flow and V_p the plasma potential) have been measured at more than 48,000 spatial locations and 7,000 time steps. The construction and deployment of the diagnostic probes conditional averaging techniques and calculation of relevant quantities will be presented. From these measurements, $\vec{J}, \vec{A}, \nabla V_p - \frac{\partial \vec{A}}{\partial t}, P = nKT$ the magnetic Helicity, and Qusai Separatrix Layer (QSL) are derived from the data. Every term in Ohm's law is evaluated across and along the local magnetic field and the plasma resistivity derived. Ohms law does not yield a physically meaningful resistivity and the data meets a condition for non-local. The Kubo AC conductivity, at the flux rope rotation frequency, is evaluated and will be presented. This yields meaningful results for the global resistivity. The temporal variation of helicity transport into the QSL is used to calculate the resistivity in the narrow reconnection region. The contribution to the power density, $\vec{J} \cdot \vec{E}$ from the region in which reconnection occurs is compared to heating in the current channels. Time domain structures (spiky electric fields) are observed to move from the reconnection region to the edges of the current channels.

* In collaboration with S. Vincena, P. Pribyl, B. Van Compernolle, S. Tang (UCLA) and R. Sydora (U. Alberta).

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PT7

Plasma-Catalysis: A Green Technology for Environmental and Energy Applications

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The rapid exhaustion of fossil fuel reserves and the adverse effects of climate change caused by increasing global energy demands have attracted great attention and pose serious threats to humankind. The emergence of new energy technologies is very crucial and essential to reduce the negative effects of climate change and to ensure global energy security based on sustainable and renewable energy sources.

Recently, the combination of non-thermal plasma and heterogeneous catalysis (known as plasma-catalysis) has been regarded as a promising and effective solution for gas clean-up and for the conversion of greenhouse gases (e.g. CH_4 and CO_2) into value-added fuels and chemicals (e.g. hydrogen or syngas) at low temperatures [1-2]. The combination of plasma and catalysts has the great potential to generate a synergistic effect, which can activate catalysts at low temperatures and improve the activity and stability of the catalysts, resulting in the remarkable enhancement of reactant conversion, selectivity and yield of end-products, as well as the energy efficiency of the process [2]. The idea of plasma-catalysis has also been extended to the synthesis, preparation and modification of catalysts to improve the activity and stability of the catalyst.

We have developed different atmospheric pressure plasma sources (dielectric barrier discharge and gliding arc) for the conversion and activation of methane, carbon dioxide and biomass tar into value-added fuels and chemicals [1-4]. The integration of plasma and catalysts clearly exhibits a significant synergistic effect, showing both the conversion of reactants and the yield of target products are significantly enhanced compared to the reaction using plasma alone or catalysis alone.

Acknowledgements

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PT8

Overview of the Hybrid Illinois Device for Research and Applications (HIDRA) Project

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Abstract

The Hybrid Illinois Device for Research and Applications (HIDRA) is the latest toroidal device in the USA, yet one of the oldest running in the world. It was originally built in France in the 1970's and is now located in Urbana, Illinois. HIDRA has the ability to operate as a stellarator and a tokamak, with the former being the primary operating configuration. It is a 5 period, $l = 2$, $m = 5$ device with 40 toroidal coils, 4 helical coils and 2 vertical coils. The vessel has a circular cross section with the major radius, $R_0 = 0.72$ m and minor radius, $r = 0.19$ m. The plasma minor radius with a limiter can vary from $a = 0.10 – 0.15$ m. In stellarator mode the long pulse or steady state toroidal field is $B_0 < 0.5$ T. Heating is through 2.45 GHz magnetron heating up to 26 kW and should achieve $T_e \sim 20$ eV and $n_e \sim 1\times10^{18}$ m^{-3}. Though the core plasma parameters are not as high as that of larger devices like W7-X or EAST, they are similar to the first wall conditions. These capabilities make HIDRA a great test bed for materials and PMI studies, as an example liquid Li technology where the science and technology can be tested, understood and perfected first in preparation for a final design that would be installed on a larger device. This talk will briefly look at the history of HIDRA from when it was WEGA in France and Germany as well as the current status, some results and discuss current PFC development for EAST and a future materials test stand (HIDRA-MAT).

Acknowledgements

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Runaway Electrons in Magnetically Confined Fusion Plasmas*

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High-energy relativistic runaway electrons (RE) can be produced during magnetic disruptions due to the strong electric field generated during the thermal and current quench of the plasma. Understanding this problem is key for the safe operation of ITER because, if not avoided or mitigated, RE can severely damage the plasma facing components. Our RE simulation efforts are centered in two complementary approaches: (i) full orbit (6-D phase space) relativistic numerical simulations in general (integrable or chaotic) 3-D magnetic and electric fields, including radiation damping and collisions, using the recently developed particle-based Kinetic Orbit Runaway electron Code (KORC) [1] and (ii) backward Monte-Carlo (MC) simulations based on a recently developed efficient backward stochastic differential equations (BSDE) solver [2]. Following a description of the corresponding numerical methods, we present applications to: (i) RE synchrotron radiation (SR) emission using KORC [1] and (ii) computation of time-dependent runaway probability distributions, RE production rates, and expected slowing-down and runaway times using BSDE [2]. We study the dependence of these statistical observables on the electric and magnetic field, and the ion effective charge. SR is a key energy dissipation mechanism in the high-energy regime, and it is also extensively used as an experimental diagnostic of RE. Using KORC we study full orbit effects, in particular collisionless pitch angle dispersion, on SR. We also discuss a recently developed SR synthetic diagnostic [3] that incorporates full-orbit information, full angular dependence of SR, and the location and basic optics of the camera. The SR diagnostic is applied to DIII-D measurements. It is shown that oversimplifying the angular dependence of SR and/or ignoring full-orbit effects can significantly modify the shape and overestimate the amplitude of the spectra.

*Work done in collaboration with L. Carbajal and G. Zhang.

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PT10

High-voltage breakdown: from surface multipactor to ionization discharge†

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High-voltage breakdown in the vicinity of a dielectric or conducting surface is examined across a wide range of conditions using theoretical and experimental treatments. Both DC and RF power sources are considered, across a wide pressure range. DC multipactor along an insulating surface can lead to local heating-driven gas desorption and ultimately to gaseous breakdown. In microwave driven systems, at low pressure, a single-surface multipactor absorbs about 2% of the microwave energy and has a mean energy of hundreds of eV. At 10-50 Torr for L-band radiation, a transition occurs from a single surface multipactor to a detached ionization discharge. Above 50 Torr, the multipactor disappears and the discharge forms a typical sheath, with mean electron energy below 10 eV. Simple scaling laws fit results in the low and high pressure regimes for several gases. Experimental results demonstrate a variable long statistical delay time, followed by a rapid breakdown. UV illumination of the dielectric surface reduces the statistical delay time, making onset of breakdown more consistent. Experiments recently demonstrated arrays of plasma filaments aligned along electric field lines, spaced ≤ ¼ wavelengths at low pressure, with filaments coalescing into more continuous diffuse plasmas at higher pressure. A 1D drift-diffusion fluid model combined with an analytic model for EM wave propagation though plasma slabs of arbitrary profile was able to demonstrate the propagation and spacing mechanisms, including decreasing spacing with increasing microwave power, as well as the diffuse plasma transition at higher pressure.

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PT11

Symplectic Maps for Diverted Plasmas

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Symplectic maps describing plasmas with a single null poloidal divertor with elongated cross sections are presented. Initially, an explicit, area-preserving and integrable magnetic field line map for a single-null divertor tokamak is obtained using a trajectory integration method to represent equilibrium magnetic surfaces [1]. The magnetic surfaces obtained from the map are capable of fitting different geometries with freely specified position of the X-point, by varying free model parameters [2]. Furthermore, non-axisymmetric stationary magnetic perturbations lead to the formation of homoclinic tangles near the divertor magnetic saddle. These tangles intersect the divertor plates in static helical structures. To obtain these structures we perturb the divertor integrable map with a nonintegrable map that simulates the effect of external symmetry-breaking resonances, so as to generate a chaotic region near the separatrix passing through the X-point. Thus the composed field line map is used to analyze magnetic footprints on the divertor plate for equilibrium configurations with different magnetic shear profiles at the plasma edge. Complementary, we also present homoclinic tangles near the divertor magnetic saddle determined by the stable and unstable manifolds obtained through an adaptive calculation providing the cuts at a given poloidal plane and the strike surfaces [3].

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Invited Talks

Non-linear Plasma Processes in Space Plasma Environments

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The high time resolution in situ wave observations show that Langmuir waves associated with solar type III radio bursts and interplanetary shocks often occur as coherent localized one dimensional magnetic field aligned wave packets with short durations of a few milliseconds and peak intensities well above the strong turbulence thresholds. We present the observations of such intense wave packets and associated density cavities obtained by the time domain sampler (TDS) of the STEREO WAVES experiment. The peak energy densities and spatial scales of these wave packets, and the widths and depths of the associated density cavities are consistent with the observed wave packets being the collapsing Langmuir solitons trapped inside the self-generated density cavities. We show that the FFT spectra of the wave packets contain the signatures of oscillating two stream instability (OTSI), namely, spectral peaks corresponding probably to up-shifted (LU) and down-shifted (LD) sidebands, and beam-excited Langmuir waves L in addition to the spectral enhancements at low frequencies corresponding probably to the ion sound waves (S); frequencies and wave numbers of these waves satisfy the resonance conditions of OTSI. These observations provide evidence for direct link between the OTSI and the collapsing Langmuir solitons trapped inside the self-generated density cavities, usually referred to as the Langmuir cavitons. We also show that the FFT spectra contain peaks at the second and third harmonics of the electron plasma frequency, f_{pe}, corresponding probably to the electromagnetic waves $T_{2f_{pe}}$ and $T_{3f_{pe}}$ excited as a result of wave-wave interactions, $L_U + L_D \rightarrow T_{2f_{pe}}$ and $L + T_{2f_{pe}} \rightarrow T_{3f_{pe}}$ as indicated by the computed bicoherence spectra of the wave packets. Furthermore, we show that for some of these wave packets, their peak intensities and widths satisfy the threshold condition for them to be the collapsing wave packets formed as a result of nucleation instability even when the level of ambient density fluctuations is higher than that of the ponder-motive force induced fluctuations. The implication of these observations for type III and type II radio burst theories is discussed.

IT2

Is CME production a stochastic process?

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We present a statistical study of the waiting time of 25207 Coronal Mass Ejections (CMEs) observed by LASCO coronographs. We found that the waiting time (WT), i. e., the time elapsed between the first observation of two consecutive events is lower than 25 hrs for the 97% of the events and is lower than 5 hrs for 59% of the events. The WT definitely does not follow an exponential nor a gamma distribution, which represent stationary and time dependent stochastic processes, respectively. On the other hand, The WT distribution can be fitted (with low probability) by either a Weibull or Pareto distributions which may represent correlation between events. The fitting process is better when we take into account the different phases of the solar cycle. In this case the WT has a slightly higher probability to follow a Pareto distribution. The mean WT for the whole period is ~ 6 hrs, and follows the solar cycle with ~ 10 hrs at minimum and ~ 4 hrs at maximum activity. The possible correlation between consecutive CME (causality) is supported by the fact that a large number of consecutive events have a Principal Angle (PA) difference within a range of ±30°. Implying that the CME tend to occur in similar source regions. Even more, analyzing the speed distribution of the leading and trailing CMEs we found a small but significant speed excess of the trailing CME when the WT is short.

IT3

Magnetic reconnection and Particle Acceleration in Astrophysical Sources and Environments

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Particle acceleration by magnetic reconnection is currently regarded as an important process not only in Solar and Space Plasmas, but also beyond it - in magnetically dominated regions of galactic and extragalactic sources like the surrounds of black holes and in relativistic jets. This process may help to solve current puzzles specially related to the interpretation of the very high energy emission produced by these sources. In this talk, I will review briefly this process, specially when reconnection is driven by turbulence, then will discuss this process in the framework of the sources above, showing recent analytical and multidimensional numerical MHD studies.

IT4

Interplanetary shocks

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Interplanetary (IP) shocks are driven in the heliosphere by fast Interplanetary Coronal Mass Ejections (ICMEs) and Stream Interaction Regions (SIRs). These shocks perturb the solar wind plasma, and play an active role in the acceleration of ions to suprathermal energies. Shock fronts evolve as they move from the Sun. Their surfaces are far from uniform and are modulated by changes in the ambient solar wind (magnetic field orientation, flow velocity), shocks rippling, and perturbations upstream and downstream from the shocks, i.e. electromagnetic waves. In this work we use multipoint observations from STEREO, WIND, and MESSENGER missions to study shock characteristics at different helio-longitudes and determine the properties of the waves near them. We also determine shock longitudinal extensions and foreshock sizes. The variations of geometry along the shock surface can result in different extensions of the wave and ion foreshocks ahead of the shocks, and in different wave modes upstream and downstream of the shocks. We find that the ion foreshock can extend up to 0.2 AU ahead of the shock, and that the upstream region with modified solar wind/waves can be very asymmetric.

Helicon Antenna Heating and its Technical Challenges at the DIII-D Tokamak

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The Helicon Antenna is a new system to drive an off-axis non-inductive current from the absorption of a toroidally directed spectrum of a very high harmonic fast waves at 476 MHz. A low-power (less than 0.4 kW) 12-element phased-array antenna was installed and used during the 2016 experimental campaign showing good antenna-plasma coupling. A high-power (1 MW) 30-element antenna is being designed to be used during the 2019 campaign that will allow measurement of the non-inductive current drive efficiency using helicon waves. This high power antenna presents new design challenges such as heat dissipation, multipactor effect suppression, S-parameter temperature dependence and disruption-induced force mitigation. All these challenges have to be managed effectively in order to have a successful and robust antenna design. Analysis of and possible solutions to these challenges will be presented.

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IT6

Impurities in the core of magnetically confined fusion (MCF) plasma: Transport, stability and diagnostic challenges

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With the selection of tungsten for the divertor in ITER, understanding the sources, transport and confinement of high-Z impurities is crucial to ITER success. Controlling impurity transport to avoid accumulation in the core is necessary to achieve and maintain high fusion performance in the presence of high-Z plasma-facing components (PFCs). In this talk we will review the impact that low- to high-Z impurities have on the averageplasma charge (Z_{eff}), resistivity and radiated power density (P_{rad}), and hence on transport, MHD instabilities and density limits. Line-emission from medium- to high-Z impurities hinder also our ability to interpret signals from conventional diagnostic systems. A new compact multi-energy soft x-ray camera has been developed at PPPL for time, energy and space-resolved measurements of the soft-x-ray emissivity in magnetically confined fusion plasmas. Being the first of its kind, this novel diagnostic will be used to resolve the impurity emission, study impurity transport and impurity-induced MHD and will become an essential part of a control algorithm coupled to physics and engineer actuators for minimizing impurity accumulation in tokamaks. This technique should be explored also as a burning plasma diagnostic in-view of its simplicity and robustness. First tests at Alcator C-Mod will be shown. Plans for current and future installations at NSTX-U, DIII-D, MST, WEST and ITER will be discussed.

Avalanches in Magnetized Plasmas

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Avalanches are sudden events that cause major changes over an extended region of a physical system. Although the concept is commonly associated with "snow avalanches", the general phenomena occurs widely in nature and in devices built by humans. The origin of avalanches is the presence of a steep gradient in one of the parameters of the system. Often there is a threshold value for the gradient; when it is exceeded, complex processes are triggered that relax the gradient below the threshold value. In an externally-heated or fueled plasma, the sources reestablish the gradient and further cause it to exceed the threshold; a sequence of avalanches can then occur. The behavior is intermittent and causes the parameters of the system to evolve from place to place, i.e., there is an associated "transport" that occurs. This type of intermittent avalanche phenomena is presently being explored[1] in a novel heating configuration implemented in the Large Plasma Device (LAPD) at UCLA. The injection of an electron beam from a masked LaB_6 cathode into a magnetized plasma results in a hollow, cylindrical filament of elevated temperature. The hot cylindrical ring has an axial extent that is about one-thousand times larger than its thickness and the peak temperature can be 10 times larger than that of the surrounding plasma. The simultaneous positive and negative radial pressure gradients provide a trigger for avalanche events that transport heat and mass across the magnetic field. This talk describes the current status of experimental observations and the associated theoretical and modeling efforts[2] to interpret the phenomena.

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Equilibrium, stability and transport studies in the TJ-II Heliac

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At ICN-UNAM we have an ongoing collaboration with the TJ-II stellarator team that has involved several aspects of interest regarding the machine experiments. The theoretical studies that we have performed will be described which involve different tools, both analytical and numerical. The magnetic equilibrium configuration is obtained using VMEC code for some specific configurations and has been used for transport and stability studies. Transport analyses have been made based on kinetic calculations using DKES code which gives mo- noenergetic coefficients of the transport matrix. This information has been used to compute radial electric fields, which are very important to determine the characteristics of transport, and to obtain the bootstrap current which is not measured in TJ-II but it is known to have relevant effects on the plasma equilibrium. The bootstrap current was used to compute self-consistent profiles for the rotational transform which can be compared to the location of the observed transport barriers since they appear at rational surfaces. A more interesting study currently underway is the dynamics of magnetic islands and their relation with transport barriers and MHD activity. A first study of the islands is being performed using SIESTA code which, unlike VMEC, allows the growth of magnetic islands when a resonant perturbation is introduced. Thus we can confirm that the islands inferred in TJ-II are actually formed at the resonant rational surfaces present in the plasma, in particular n/m = 8/5 and 12/8. The island dynamics is analyzed studying the nonlinear stability of the tearing mode together with the torques resulting from the external perturbation and the viscosity. Then, a model is proposed for the interplay between magnetic islands and transport barrier forma- tion based on a double bifurcation mechanism. This model is implemented with the Astra transport code which incorporates an anomalous transport model that stabilizes fluctuations via a sheared flow.

Measurements of metallic gas properties by means of an exploding wire experiment

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An exploding wire experiment consists of a thin metal wire, typically with a diameter of the order of micrometers and milimeters to centimeters in length, through which a large electrical current is discharged, causing the metal to transform into plasma, through intermediate states.
It is a phenomenon known to science for a long time [1] and has therefore been used in multiple scientific research [2,3,4]. The electrical energy absorbed by the explosive wire system until it has become plasma is a key feature in the later development of the phenomenon [5]. In fact, the state of a wire expanding in vacuum and its homogeneity are determined by the electrical energy absorbed [6] and the temporal rate of the current [7]. Depending on parameters such as energy density, electrical power, and current rate, the transition from solid to plasma may be very different. Using large values of the mentioned parameters, Warm Dense Matter conditions are achieved, while at lower values classical transitions are expected.
With such a rich and profound changes of state, exploding wires are excellent test benches for equations of state of metals under conditions difficult to reach with other experiments. Indeed, there is a large number of scientific works that use an exploding wire setup to either test equations of state of metals or directly to obtain experimental values of constitutive magnitudes of the metals, such as [8,9,10].
During the evolution, shortly after the initiation of the discharge, when the wire material has been converted into gas, its electrical conductivity is so low that the current almost stops until further heating of the gas allows the formation of plasma [3,11]. This is the so-called dark pause, a stage that has not been properly addressed, because the final plasma state is usually seek.
In this work we described the case when, by an appropriate choice of the parameters, a convenient long dark pause is produced in order to study the constitutive properties of classical metallic gases, from the boiling up to the ionizing temperature.

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IT10

Experimental and theoretical study of a contracted glow plasma jet discharge

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Atmospheric-pressure plasma jet discharges are very interesting because of their wide range of technological and bio-medical applications. These devices are relatively simple, of easy operation and are very efficient sources for the production of highly reactive species.

We study a plasma jet generated by applying an ac high voltage (kV) of low frequency (50 Hz) between two electrodes separated by a dielectric material and operated with air and argon. From the electric voltage-current characteristic measurement it was found that this plasma jet could be explained by an arc-like main channel plus a cathode layer with a large voltage drop (contracted glow). The comparison of model and experiment indicates that the discharge can be effectively sustained in its contracted form by the emission of secondary electrons by ion impact and by additional mechanisms like collision of atoms excited at metastable levels and field-enhanced thermionic emission. Moreover, the fit of the model to the voltage-current characteristics allows determining the plasma state in the discharge, including profiles of electron, gas, and molecular nitrogen vibrational temperatures, which compare well with the spectroscopic data.

Also, design modifications of the discharge, in collaboration with other groups, to fulfill the needs to develop safe and reliable plasma devices for medical use are discussed.

Morphology of the expansion of a plasma created by means of exploding wires.

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When a large electrical current passes through a metallic wire in a short period of time, by Joule heating, the wire becomes liquid and later plasma, a phenomenon known as exploding wire.

If the wire geometry and power delivered to the wire are adequately chosen, then the electrical energy absorption by the metal happens in two different stages. In the first step, a cold plasma is created, meanwhile in the second stage a warmer, more energetic plasma that absorbs other fraction of the energy, generating a very bright plasma with many inhomogeneities visible in its expansion. The present work is dedicated to describe the morphology of this two-stages plasma formation.

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IT12

Small Dense Pulsed Plasma Discharges Program at the Chilean Nuclear Energy Commission
Basic Research and Applications to Fusion, Materials and Biology

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Pinch plasma discharges are pulsed sources of dense plasmas, ions pulses, X-rays pulses, neutron pulses, plasma shocks and supersonic plasma jets. The duration of the pulses is in the range of ns to hundreds of ns. At the Chilean Nuclear Energy Commission, pinch discharges as z- pinches, x-pinches, wire arrays, and plasma focus are being studies since some years ago. Several diagnostics have been developed in our laboratory to characterize the plasma and their emissions: a) voltage and current monitors, b) visible plasma images with temporal resolution used an ICCD camera, c) neutrons detection: total yield and temporal resolution using photomultiplier and plastic scintillator, d) x-rays: images using pinhole cameras with filters in time integrated mode and with temporal resolution using a MCP camera, temporal detection using photomultiplier and plastic scintillator, and total doses, e) ion beams: Faraday cup and Thomson mass spectrometer, f) visible and x ray spectrometer, and g) digital optical refractive diagnostics. Recently a theoretical and simulation research line is being implemented to complement the experimental studies.

On the one hand, the plasma focus experiments have been extended to sub-kilojoules devices and the scales rules have been stretched up to region less than one joule. A brief review of the most recent results using tabletop plasma focus devices for basic research and applications is presented: a) scalability, similarities and differences in plasma focus devices, b) studies of filamentary structures, toroidal singularities, plasma bursts and plasma jets generations, c) pulsed radiation applied to biological studies, d) the use of plasma focus devices as plasma accelerators for studies of materials under intense fusion-relevant pulses, and e) synthesis of DLC materials. In addition, the conditions to use a plasma focus as a neutron seed for an hybrid fusion-fission generator have been calculated.

On the other hand, the development of compact pulsed power generator to drive wire arrays and x-pinch discharges, and recent results of plasma dynamics and x-ray pulses are presented. Possible applications of are discussed.

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Review of Plasma Rotation Results Obtained in TCABR Tokamak

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Poloidal and toroidal rotation play an important role in transport of energy and particle and can suppress magnetohydrodynamic (MHD) stability in toroidal magnetic configuration systems. In general turbulence suppression and consequently improvement of heat and particle transport appear when there is a $\boldsymbol{E} \times \boldsymbol{B}$ shear of poloidal rotation. The toroidal rotation can contribute to stabilize MHD instabilities such as resistive wall modes and neoclassical tearing mode if some level of rotation is achieved.

Despite a long history of studying the plasma rotation, toroidal rotation still attract considerable attention of scientific community because for wall resistive modes stabilization some level of toroidal velocity is needed and for reactor-size devices such as ITER, the external momentum input is expected to be small. Therefore, it is very important to understand the physical mechanisms responsible for plasma rotation, in order to predict the plasma behaviour in reactor machines.

In general, plasma rotation is measured by Doppler shift of spectral lines which are, in the most of cases spectral lines of plasma impurities. The main problem in this kid of measurements is that the Doppler shift of spectral lines is very small, (~ 0.1 A) which makes these measurements extremely difficult. In this work we are summarizing the results that were obtained in TCABR tokamak, for poloidal and toroidal rotation of carbon spectral lines, discussing in detail the methods employed and comparing with theoretical predictions.

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The effect of the geometry of the magnetic field on the trajectory of the secondary electrons and the shape of the erosion race track in a magnetron cathode

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Magnetron sputtering involves the exchange of momentum between ions from the magnetically confined plasma and the cathode target, with this producing the emission of atoms from the target towards the substrate. The form of the racetrack in the target is determined by the distribution of the ions incident on the target, and this depends on a combination of the strength and configuration of the magnetic field. In this study we have measured the spatial variation of the magnetic field of different diameter and type of magnetron cathodes, each of different maximum magnetic field strengths. We have compared that magnetic field data with the spatial distribution of the erosion racetrack in the corresponding targets. The results showed that the inner and outer edges of the racetrack correspond to given value magnetic field vector. We report the relationship between the racetrack profile and the configuration of the magnetic field. We have also attempted to simulate the trajectories of the secondary electrons emitted from the cathode surface and relate these to the form of the plasma and the lateral distribution of the energy of the ions incident on the target.

Keywords: Magnetron sputtering, racetrack, magnetic field

IIM2

Overview of Plasma Processing on the Semiconductor Industry

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Low-temperature plasmas are critical for the manufacturing of all microprocessors. These plasmas are used throughout all the manufacturing process including deposition layering, lithography, etching, and cleaning. These plasmas operate in different regimes and the equipment where these plasmas are produced have a different configuration. Due to the critical reliability of the manufacturing processes, this equipment has to follow a very precise maintenance schedule depending on the different processes they run. A description of the manufacturing process and its challenges, as well as the research and development procedure in the semiconductor industry, will be given.

Oral Contributions at ICN

Photoionized jets from massive young stars

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Massive, young stars produce a strong extreme UV radiative field that photoionizes the surrounding ISM, producing a “compact photoionized (H II) region” which surrounds them (these compact H~II regions being embedded in the molecular cloud out of which the young stars are formed). It is not clear whether or not these massive young stars also eject bipolar jet systems in a similar way to what is found in low mass young stars. This uncertainty is due to the fact that it is difficult to detect jets (possibly ejected by massive young stars) against the background radio, free-free emission of the surrounding H II region.

The main mechanism for ionizing the jet material is of course photoionization (as expected for massive stars with large production of EUV radiation). However, the direct radiation from the star is trapped in an ionization front close to the surface of the star (due to the high jet density in this region), and the jet beam is initially neutral. At larger distances from the star, the surface of the jet beam gets progressively more photoionized by the ``diffuse" ionizing radiation produced by the surrounding H II region.

An analytic model of this process leads to concrete predictions of the brightness (in the radio, free-free continuum) of the jets relative to the background H II region. We find that for the parameters expected for a jet from a massive young star the jet should be of approximately 20% brighter than the surrounding H II region. It should therefore be possible to detect them (if present) in high signal-to-noise interferometric maps of appropriate objects.

Detection of drift-mirror instability and High beta plasma observations in Earth's inner Magnetosphere

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We report on high beta (> 1) plasma observations made by the RBSPICE instruments onboard NASA's Van Allen Probes spacecraft. The data presented covers almost two years of continuous measurements (March 9, 2013 to December 31, 2014). This coverage provides an unprecedented opportunity to identify and characterize high-beta plasma occurrences in the inner magnetosphere and their characteristics. It is known that high-beta events involve complex plasma physics dynamics. These events can also have global effects on Earth's magnetosphere. Here we show that on July 6, 2013 (one of many high-beta events) a Pc5 (~ 2.5 min period) wave was locally generated in the magnetosphere through the drift-mirror instability. We describe the wave characteristics and its effects on particle modulations, specifically ring current ions (~ 50-500 keV).

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O3

The seesaw space, a vector space to identify and characterize large-scale structures at 1 AU

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We introduce the seesaw space, an orthonormal space formed by the local and the global fluctuations of any of the four basic solar parameters: velocity, density, magnetic field and temperature at any heliospheric distance. The fluctuations compare the standard deviation of a moving average of three hours against the running average of the parameter in a month (consider as the local fluctuations) and in a year (global fluctuations) We created this new vectorial spaces to identify the arrival of transients to any spacecraft without the need of an observer. We applied our method to the one-minute resolution data of WIND spacecraft from 1996 to 2016. To study the behavior of the seesaw norms in terms of the solar cycle, we computed annual histograms and fixed piecewise functions formed by two log-normal distributions and observed that one of the distributions is due to large-scale structures while the other to the ambient solar wind. The norm values in which the piecewise functions change vary in terms of the solar cycle. We compared the seesaw norms of each of the basic parameters due to the arrival of coronal mass ejections, co-rotating interaction regions and sector boundaries reported in literature. High seesaw norms are due to large-scale structures. We found three critical values of the norms that can be used to determine the arrival of coronal mass ejections. We present as well general comparisons of the norms during the two maxima and the minimum solar cycle periods and the differences of the norms due to large-scale structures depending on each period.

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O4

Vacuum magnetic flux surface measurements on the SCR-1 Stellarator

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The Stellarator of Costa Rica 1 (SCR-1), located at the *Instituto Tecnológico de Costa Rica,* is the first Stellarator of Latin America [1]. In Stellarators, vacuum magnetic flux surfaces are produced only by external coils [2], making respective property measurements possible. Flux surfaces allow the magnetic confinement of plasma, making their characterization important to verify the device's construction. The aim of this work is to present measurements on the flux surfaces in the SCR-1.

Mapping of the magnetic surfaces produced in the SCR-1 implied the use of a transparent fluorescent screen covered with ZnO:Zn phosphor which allows the detection of an electron beam, emitted from an electron gun inside the vacuum vessel, that travels around the device following the magnetic field lines. Three highly transparent screens were used: a fixed stainless steel mesh, an oscillating rod, and an in-house elliptical design called *"cuchillo de mantequilla"* (butter knife); and results were compared between them. Using the three different methods in the toroidal position 0°, three different nested surfaces were measured. Finally, results were compared with the Poincaré maps from BS-SOLCTRA (Biot-Savart Solver for Compute and Trace Magnetic Fields) and EXTENDER_P (formerly Poincare) codes [3][4]. The obtained results are consistent with expectations, verifying that the manufacturing process of the coils was handled as designed.

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Using the anisotropy of observational maps to study interstellar turbulence

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It is well recognized that the interstellar medium (ISM) is magnetized and turbulent. In recent years there has been a significant effort to understand the properties of this turbulence, both from a theoretical, as well as an observational perspective. An observational consequence of such anisotropy becomes evident in maps of column density and velocity centroids. I will present an overview of the study of such anisotropy from synthetic observations from a grid of MHD turbulence simulations with varying sonic and Alfvenic Mach numbers. It is found that the degree of anisotropy depends mostly on the Alfvenic Mach number of the turbulence, giving valuable information that can be easily obtained from observations.

Optical Design of Wide Field and High Resolution Objectives for Spectroscopy Measurements in the TCABR Tokamak

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The analysis of stray light radiation is the study of all unwanted sources that can reaches a detector, and can be considered as noise in an optical system. Recently, the optical group of TCABR tokamak start to use a new tool to correctly diminish the undesirable signal, the so called "Optical Transfer Function". The initial purpose is the investigation of ion temperature profile and impurities distribution measurements. Computational analyses of OTF shows that lens system performance can be highly improved in rejecting stray light, to meet better contrast and image quality. In this work, we discuss the magnitude and fissility of this improvement.The Optical Group nearly born in TCABR is bringing computational analysis of new devices to reality. Using the cloud storage and processing, researches can now interact to each other, changing experience and creating new collaborations. The system is available to all students sharing a network connection. We thank FAPESP and CNPq for the support.

O7

Modeling of hybrid fusion/fission systems for development of advanced nuclear fuel cycle

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The main concept of the hybrid system [1–7] is the production of neutrons from the fussion side. Fusion boast a neutron plethora while fission copes with a neutron dearth. Hybrid means a couple of deficit with a surplus, of course, this also means a very complex technological solution. Fusion-Fission hybrids, driven by a copious source of fusion neutrons can open qualitatively "new" cycles for transmuting nuclear fertile material into fissile fuel and to destroy high radio toxicity actinides [8]. A totally reprocessing-free (ReFree) Th 232 –U 233 conversion fuel cycle is presented [9], as well as burn up cycle for spent fuel. Virgin fertile and spent fuel rods are exposed to neutrons in the hybrid, fissil isotopes are then burned in a traditional light water reactor, without ever violating the integrity of the fuel rods. Through-out this cycle (during breeding in the hybrid, transport, as well as burning of the fissile fuel in a water reactor) the fissile fuel remains a part of a bulky, countable, ThO 2 matrix in cladding, protected by the radiation field of all fission products. This highly proliferation-resistant mode of fuel production and the destruction of radio toxisity spent fuel, can bring great acceptability to the nuclear industry fuel production and final disposal on spent fuel. It also provides a reprocessing free path to energy security for many countries.

MCNP and Monteburns [10-11] are the standard codes used to make analisys tasks, embracing a detailed 3D neutronic geometry. UNIX's scripts developed by University of Texas (UT) at Austin can built almost any capacity Hybrid Nuclear Reactor MCNP & Monteburns input models automatically with flexible scripts for rapid exploration. Computer capacity is also as important as the tools chosed for the project developing, that is why MCNP & Monteburns are installed and running in a supercomputer (Abacus-I) from Instituto Politecnico Nacional (IPN) in Mexico. At the beginning a 400 MW power fusion reactor model is completed and running. This model is being adapted to be coupled with a blanket fission section for burning wasted material and breeding fertil isotopes. Continuity and energy field equations are going to be the corne stone of these calculations. Energy provided by the fusion section must be capable to feed burning and breeding processes, tryning to find out an optimal fuel management array in the fission blanket section.

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Evolution of fractality in magnetic clouds

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Complexity studies in plasma physics have been of great interest as they provide new insights and reveal possible universalities on issues such as geomagnetic activity, turbulence in laboratory plasmas, physics of the solar wind, etc. [1] In particular, the existence of fractal features in systems as diverse as the Earth's magnetosphere, the solar wind and the solar photosphere has been discussed by several authors. In previous work, we have studied the temporal evolution of fractality for geomagnetic activity, by calculating fractal dimensions from *Dst* data.[2] It has been found that the fractal dimension decreases during magnetic storms, effect which has been observed on several time scales, ranging from individual storms to a complete solar cycle. Results suggest that the fractal dimension is a useful way to characterize the state of a magnetized plasma. In this work, we apply a similar method to study the time series for the magnetic field during transient events such as magnetic clouds,[3] as found in ACE data.[4] It is found that the calculated fractal dimension evolves in a distinctive way as the various stages of the event pass by the spacecraft (namely surrounding solar wind, sheath, and flux rope), suggesting that the fractal dimension is able to characterize the magnetic cloud structure. The dependence of the results on the time delay to sample the data is also studied.

Data are studied for the total magnetic field, as well as for each Cartesian coordinate as registered by the spacecraft. Some differences are found when individual coordinates are studied, but consistent results are recovered when axis are chosen according to a minimum variance criterion.

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Design, methods, tests, applications to solar physics and potential new applications of a new ideal and resistive MHD code

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We present our MHD code designed to solve the equations of classical ideal and resistive magnetohydrodynamics in three dimensions coupled to a constant gravitational field. The purpose of the code centres on the analysis of solar phenomena within the photosphere–corona region. We present 1D and 2D standard tests to demonstrate the quality of the numerical results obtained with our code. The numerical methods involve a finite volume discretization, the method of lines for the evolution that uses High Resolution Shock Capturing methods, including Harten–Lax–van Leer–Einfeldt (HLLE) formula and the more modern inner discontinuities hunters HLLC and HLLD fluxes, combined with Minmod, MC, and WENO5 reconstructors. The divergence free magnetic field constraint is controlled using the Flux Constrained Transport method. Some applications are mentioned, which include: i) the generation of jets due to magnetic reconnection in the photosphere- corona interface, which have the characteristics of spicules and ii) the evolution of the plasma within realistic three dimensional magnetic field configurations.

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O10

Kelvin-Helmholtz instability at sheath-solar winds interface

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The Coronal Mass Ejections (CMEs) are known as the strongest ejections of plasma and magnetic field in the solar wind (hereafter SW). The CME velocities can be in ranges from 50 km/s to 2000 km/s, and sometimes reaching 3000 km/s (Yashiro et al., 2004). The fast CME (>800 km/s) drive to sheath and shock wave ahead the ejection by SW plasma compression (e.g. Bacchini et al. 2015 and references therein). The shock formation is evidenced by type-II radio bursts in heliocentric distances below 2 R_sun. At the interface between the sheath and the SW (hereafter Sh-SW) may exist shear flows that allow the formation of the Kelvin-Helmholtz instability (hereafter KHI) (e.g. Manchester et al. 2005). Recent observations show the formation of the KHI in the CMEs ambient in low corona distances (Foullon et al. 2011, Ofman & Thompson 2011, Mostl et al. 2013). In our work we show a theoretical analysis for the KHI existence at Sh-SW interface in the heliocentric distances of the outer corona between 4 R_sun to 30 R_sun. We study the Sh-SW interface for two CMEs propagating through the slow and fast SW. We model velocities, densities and magnetic field intensities of the sheaths and the SWs, for the shock flanks and shock equatorial plane, in order to solve the Chandrasekhar (1961) condition for the KHI formation. We find the constraints for the SW magnetic field values appropriated for the KHI formation. Calculations show that KHI formation is more likely in a CME propagating in the slow SW than in the fast SW, due to large shear flow between the CME and the slow SW.

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O11

ISTTOK Real Time Magnetic Multiple input-Multiple output Control

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The plasma current poloidal shape and its centroid position are vital for obtaining advanced performance regimes in tokamak operation. For that aim the use of poloidal magnetic coils for feedback control is essential in present devices and expected to be of paramount relevance in future tokamaks. These control systems allow the plasma to be maintained within prescribed limits of its position and shape (A. Pironti, 2008).

Using the ISTTOK tokamak magnetic system, composed by a set of two poloidal field coils, the real-time control of the plasma centroid position is made possible by the execution of a Generic Application Module (GAM), developed to be executed on the I Multi-threaded Application Real-Time executor (MARTe) ISTTOK controller (André C. Neto, 2010). This Control GAM receives as input signals the vertical and horizontal positions of the plasma current centroid from an already implemented Position GAM. The output signals given by the Control GAM are the applied currents to the tokamak poloidal field coils (Carvalho I S., 2008). The Control GAM performs the feedback loop through an optimal control matrix gain based on a reconstruction of a linear state-space model that uses data collected from experimental open-loop discharges.

The Position GAM reconstructs the vertical and horizontal positions of the plasma current centroid through the data collected in a set of 12 magnetic (Mirnov) probes and the numerical integration of these signals computed in the recently upgraded hardware based on the Advanced Telecommunications Computing Architecture (ATCA). This technic allows an optimal signal integration avoiding the usual drifts by a suitable dynamic calibration (Bernardo Carvalho, 2017). The Control GAM implements a Multiple input- Multiple output (MIMO) control allowing an upgraded performance on the actuators in order to attain a certain plasma current centroid position.

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Drift wave transport in a plasma with a thermal distribution of Larmor radii

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Drift waves are recognized as the main source of plasma turbulence in magnetically con- fined plasmas since they appear as a result of pressure gradients which are always present. The turbulent fields give rise to particle transport at a realtively fast rate. The resulting $\mathbf{E}\times\boldsymbol{B}$ transport of a test particle can be studied from a Hamiltonian description where the elec- trostatic potential plays the role of the Hamiltonian. Here we consider an infinite spectrum of drift waves in two-dimensions representing the radial and poloidal directions in a toroidal device, propagating poloidally [1]. The evolution is reduced to a 2-D map that can be it- erated efficiently and we include the finite Larmor radius (FLR) by taking the gyroaverage over one period. When the amplitude of the waves is increased the mapping becomes chaotic leading to turbulent transport. As it was found in previous studies [1,2], the FLR effects tend to reduce the amplitude for the transition to chaos, thus improving the confinement of fast particles. We present an analysis of the phase-space structure of the particle motion from regular to chaotic and study how the fraction of trapped particles evloves as the wave amplitude increases. The statistical properties of the transport are derived finding that it is diffusive and the particle distribution functions (PDF) are Gaussian. Then we consider a thermal distribution of Larmor radii for the particles as a more realistic description which leads to an important change in the PDFs: they become non-Gaussian with long tails while the transport stays diffusive. This behavior is explained theoretically. In the second part a sheared flow in the poloidal direction is added to the waves. A symplectic mapping can be produced when the flow is monotonical. This contribution has the effect of increasing the poloidal transport quite importantly appearing Levy flights for large fraction of particles. This renders a super-diffusive transport while the PDF does not deviate much from a Gaus- sian, when all particles have the same Larmor radius. The radial transport is not affected and stays diffusive. For a thermal distribution of Larmor radii the PDF again deviates sub-stantially from a Gaussian. This shows the importance of including FLR effects to determine the nature of chaotic transport.

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Confinement improvement during edge plasma biasing in the TJ-II stellarator

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It has been proposed that the onset of the transition from the *L* mode to the *H* mode in tokamaks and stellarators is triggered by a sudden change of the radial electric field, E_r, to a more negative value, which reduces the fluctuation amplitudes and consequently suppresses the turbulence [1]. Experiments in TJ-II showed that it is possible to modify the global confinement and edge plasma parameters with limiter biasing, illustrating the direct impact of a radial electric field on TJ-II confinement properties, which was shown through measurements by the heavy ion beam probe diagnostic of the core potential [2]. In this work we study the plasma response to a biasing electrode using a transport model that includes neoclassical and turbulent contributions. The electrode is assumed to produce a localized radial current near the edge that affects the ambipolar radial electric field E_r. The sharp local change in E_r triggers the confinement improvement around the edge region, by suppressing turbulent fluctuations due to the shear of the angular velocity. For the anomalous transport we use resistive ballooning modes including the stabilizing effect of $\mathbf{E} \times \mathbf{B}$ shear; this self-consistently allows the formation of transport barriers [3]. The simulations are made with the ASTRA transport code [4] exploring different operating scenarios with positive and negative bias.

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O14

Fluctuations dynamics for a relativistic single component plasma in the electrostatic case.

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The kinetic theory of relativistic gases has been a subject of particular interest in the recent years. Within its predictions, it has been found that dissipation in high temperature charged gases is comprised of three effects. First, the usual Fourier-type heat conduction in which the thermal conductivity is enhanced by relativistic corrections. Second, both the density and electrical potential gradients drive purely relativistic contributions to the heat flux which resemble the thermal diffusion and thermoelectric effects respectively and have no non-relativistic counterpart from the kinetic theory point of view. The third modification in plasma transport due to the relativistic motion of particles in very hot gases consists in a heat flux-driven contribution to the momentum balance equation. In this work we establish the linearized equations for a single component charged fluid including these effects. The system is coupled to Gauss' law in a purely electrostatic approximation where the electric field is given by the fluctuations in electric charge density. The corrections to the dynamics of the state variables fluctuations are analyzed and compared to the non-relativistic and non-dissipative scenarios in order to discuss the corrections in the form and parameters involved in a Rayleigh-Brillouin spectrum. The implications and possible generalizations of the results are briefly discussed.

Oral Contributions at IMM

OIM1

Non-thermal atmospheric-pressure plasma activation of herbal seeds indicating the acceleration of the plant's germination period

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Results of Experimental studies regarding utilization of a Dielectric Barrier Discharge (DBD) device that generates Non-Thermal atmospheric plasma and activates vegetables herbal seeds will be shown. A variable power voltage and frequency supply was used to perform the plasma activation of the seeds. The voltage varied from 2 KV to 10 KV, and the frequencies from 2.5 KHz to 10 KHz. The Non-thermal plasma system was fixed on a platform, and the seeds were located on a plate underneath of the Non-Thermal Plasma Device. The platform was set up on a lift table so that the separation distance between the seed's surface and the DBD device surface could be adjusted to meet the optimal separation distance of 3 mm. An optimum time of 3 minutes was used, which was previously determined empirically by the coauthors at Kyushu University in Japan. After plasma treatment, treated seeds and non-treated seeds were planted side by side. Depending on herb variety, the germination time of the Non-thermal plasma treated seeds varied from 3 to 4 days and the non-treated plasma seeds varied from 4 to 8 days. The experimental results discussed in this paper prove that plasma activation in seeds accelerates the germination rate of the plants.

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Application of a Three-electrode Plasma Reactor for CO Treatment

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The study on CO elimination has a great importance because it is a very toxic molecule, regarded as one of the most dangerous contaminants [1].
In this work, we present a study on a three-electrode plasma reactor to treat CO gas in a N_2 atmosphere. The reactor combines a dielectric-barrier discharge (DBD) with a remote, negatively biased third electrode. The DBD is generated by applying an alternating high voltage signal between two circular aluminum flat electrodes attached to opposite sides of a disc made of dielectric material. The third electrode consists in an external cylindrical mesh, coaxial with the DBD electrode system, and fixed to the inner wall of an insulating tube. The air gap between the edge of the DBD electrode system and the mesh electrode is approximately 20 mm wide. The discharge is composed of trains of streamers crossing the air gap through which the gas to be treated flows. Several DBD electrode systems can be connected in parallel along the reactor axis; hence a large plasma volume can be established [2]. The reactor was operated with a gas flow of CO 350 ppm, N_2 balanced, and a significant CO removal was observed. CO elimination can be effected either through dissociation by electron impact, or through reactions with reactive species generated by electron collisions. In both cases the necessary energetic electrons are produced in the streamers.

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OIM3

Characterization of PG-QRO-1 Intermediate Energy Deuterium Plasmas

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The study of the interaction of magnetized plasmas with candidate materials for fusion reactors, is a main topic in fusion research. While Plasma Simulators can produce intense beams their energy is usually limited to a few tens of eV. Plasma Foci, on the other side, produce a large spectrum in energy with energies ranging up to tens of keV. The plasma-gun PG-QRO-1 has been tailored to produce plasmas with relevant densities but limiting the high energy spectrum in order to use it for plasma-wall.-interaction studies. Deuterium low energy plasmas have been exposed to Tungsten polycrystalline and Titanium control samples. The deuterium retention profiles in both materials are very shallow with penetration depths of the order of tens of nm.

OIM4

Warm Plasma Torch for Hydrocarbon Reforming

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The present study demonstrates a reforming process realized by a warm plasma reactor combining a vortex effect during GHG entrance to the plasma reactor chamber accomplishing a high CH_4 and CO_2 conversion as well high yield hydrogen recovering.
The conversion of hydrocarbon in by-products with high added value is mainly contributed by dissociation and ionization processes. Warm plasma is environment-friendly and auto-sustainable processes, moreover the electric discharge has low specific energy requirement still maintaining enough high temperature (1000-3000 K) to produce excited species, supporting subsequent chemical reactions. Such plasma discharges have significant advantages: Do not require extra cooling systems, since they work with reduced electric current flows and high voltages, avoiding electrodes erosion. Consequently, reactors can be achieved with a simpler framework and high capacity gas treatment.
Plasma interaction with GHG´s, leads to a molecular dissociation, mainly forming CO and H_2, also known as syngas. In recent years, the syngas has become one of the alternative energy sources more profitable and investigated. This mixture, normally recovered from the decomposition of organic material, provides energy power with innovative applications in microturbines and fuel cells, in conjunction with others applications.
In addition an experimental analysis by using pulsed or resonant converter power supply is conducted; these features facilitate the maximum energy transfer to the plasma without using more complex electronic structures. Electric analysis was performed to determine instantaneous current, voltage, and power applied in the Warm Plasma Torch for GHG treatment. From analysis of power consumption, the SE and ECE are obtained.
The effect of frequency, duty cycle, voltage and current wave form signals is here described. The main features and advantages of this configuration are also defined.

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Multilayer graphene growth assisted by sulfur using the arc discharge method at ambient conditions

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Graphene, a two dimensional hexagonal array of carbon atoms, has interesting physical properties[1] which make this material potential in many applications[2]; such as in energy storage devices, for example as electrodes in supercapacitors[3]. The most common methods to synthetize graphene or many stacked layers of graphene (Multilayer Graphene, MG) are mechanical exfoliation of graphite crystals, CVD using hydrocarbon vapor and copper as a catalyst and exfoliation of graphite crystal in a liquid media [2]. In the present work we explore the alternative method based on the arc discharge [4], a technique usually employed for the synthesis of carbon nanotubes. Our approach is the use of sulfur as a promoter of sp^2 bonds to form graphite domains at high temperatures [5].
The electrodes consist of carbon rods, the rod used as the positive electrode has a cylindrical hole filled with a mixture of carbon and sulfur powders. The DC discharge was made using compressed air at ambient pressure; the resultant black powder was studied by Scanning Electron Microscopy and Raman spectroscopy.
Raman spectroscopy is a useful technique to characterize the different carbon allotropes. In particular, graphene and MG are characterized by G and 2D Raman bands, where the number of graphene layers in MG is mainly determined by the form of the later band [6]. When structural disorder and/or impurities exist in the material then a D band appears, and the ratio of the D/G band intensities gives a measure of the disorder in the sample. Our results indicate that the carbonaceous material obtained without the addition of sulfur has a very defective graphitic structure, but when sulfur is added the ratio of the G/D intensities is less than one and the 2D band is consistent with a MG material. Studies of plasma were realized with optical emission spectroscopy and excitation temperatures around 5000K were obtained using S I lines; this indicates the existence of reactive sufur species which may induce the formation of graphitic domains.

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OIM6

Surface Modification of Graphene Nanoplateletes (GNPs) with Radiofrequency Plasma or High Voltage for the Preparation of Polypropylene/GNPs Nanocomposites

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The surface modification using radiofrecuency plasma or high voltage are two methods that offer very versatile options to modify surfaces. Precision cleaning of contaminated components, the plasma activation of plastic parts, etching and coating of plastic parts by plasma polymerization are among the applications. The grapheme nanoplatelets (GNPs) are being extensively investigated, due to the outstanding properties and promising applications. They are very like two-dimensional graphene, but with a low cost of production. Several researchers have proposed to obtain nanocomposites using GNPs and different polymer matrices. This study works with two techniques of surface modification: radiofrequency plasma and high voltage (HV) for the preparation of polypropylene/GNPs (PP/GNPs) nanocomposites, using propylene (C_3H_6) as the monomer gas. The surface modification of the GNPs promotes a better dispersion in the PP matrix, as well as the increase in thermal and mechanical properties of the obtained nanocomposites. Plasma modification was performed in two types of reactor .The radiofrequency plasma reactor (RF, 13.56 MHz) was used where the pressure was $4x10^{-1}$ mbar, modification times of 60 and 90 minutes with a plasma power of 50W. On the other hand, a HV reactor where the conditions of use were, a pressure of $5.5x10^{-1}$ mbar, modification times of 30 and 90 minutes with a plasma power of 70W. The PP/GNPs nanocomposites were prepared at concentrations of 3 and 8 % by weight of GNPs. They were obtained by mixing PP and GNPs in a Brabender chamber at 190 °C and 60 rpm. The physicochemical and thermal properties of the GNPs were evaluated by X-ray diffraction, thermogravimetrical analyses (TGA) and dispersion in solvents (water and trichlorobenzene). The PP/GNPs nanocomposites were characterized by TGA, DSC and stress tests. The surface modification of the GNPs promotes a better dispersion in the PP matrix. An improvement of the thermal properties of the PP/GNPs nanocomposites and an increase of the Young's modulus of up to 50% was found in relation to the pristine PP; with higher changes observed in nanocomposites containing GNPs treated in the high voltage plasma reactor.

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OIM7

Hydrodynamic effect of discharge of dielectric barrier in the flow of air around an airfoil NACA 0018.

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The presented work is aimed to study the boundary layer re-attachment of flow over an airfoil at high angles of attack. To promote the reattachment, a flat profile with an asymmetric DBD actuator on one of its surfaces was built based on the optimization improvements of the actuator [1], [2] to observe its effect at quiescent flow conditions. Subsequently, asymmetric actuators were tested in streamwise and spanwise orientations on the upper surface of a NACA 0018 aerodynamic profile. The plasma actuators were installed symmetrically between the leading edge and trailing edge of the profile. Lift coefficient and drag coefficient were measured in a wind tunnel with and without plasma actuation for a range of angles of attack. When powered, the plasma actuator generates a surface discharge on the aerodynamic profile surface, and this plasma layer provides, through Lorentzian collisions, a purely electrohydrodynamic coupling between the electric field and the neutral gas in the boundary layer. This coupling is strong enough to cause aerodynamically significant acceleration and manipulation of the boundary layer and free stream flow [3]. The effect of the actuator on the flow was visualized by means of a Schlieren type-z optical arrangement with a viewing area of 31 cm^2. The electrical parameters of the discharge were generated by a radiofrequency source operating 1-16 Kv_{pp} at a frequency 17-35 KHz. The NACA 0018 profile was subjected to laminar flow within a subsonic wind tunnel. The wind tunnel has a test section of 40*40 cm and the maximum flow velocity is 20 m/s.

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Synthesis of carbon nanostructures using plasma, study of electrical parameters and their influence on nanostructures formation

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Carbon has several interesting aspects, among them, the flexibility to configure the electronic states of their atoms and therefore the union between atoms bonds, which allows it organized in diverse forms to build unique nanostructures (1-D, 2-D and 3-D) that having physical, chemical and mechanical properties that can be exploited in a wide variety of applications. In this work the synthesis of carbon nanostructures by plasma is presented, both electronic power source and reactor used are designed and constructed in our laboratory, also study and characterization of electrical discharge parameters (power, reactor geometry, pressure, temperature, flows rates, reactants and catalysts) is showed. Other works has synthesized graphene and carbon nanotubes (CNTs) by techniques of electrochemical synthesis and chemical vapor deposition and enhanced plasma chemical vapor deposition both at reduced and atmospheric pressure [1, 2], however the aim of this study is to obtain high production of powder of carbon nanostructures. In order to [3], collisions of high energy reactive species provide energy for nucleation process of graphene and CNTs, graphite electrodes are used with a mixture of catalysts (nickel, yttrium, iron and graphite) previously deposited to induce a nucleation effect that starts at the perimeter of the catalysts and begins to propagate in layers or the normal direction to the electric field to promote the growth of carbon nanostructures.

The characterization of the structures of the material synthesized by transmission electron microscopy (TEM) and scanning (SEM), X-ray diffraction and Raman spectroscopy are presented. A study of the electrical parameters in the generation of the plasma discharge and their influence in the formation of reactive species so that they begin to form bonds between atoms of solid carbon and create nucleation sites that incite ordered grow nanostructures, especially graphene nanoplatelets (GnPs).

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OIM9

Surface Modification of Graphene Nanoparticles with Ethylene Plasma in Rotary Plasma Reactor for the Preparation of PE/G Nanocomposites

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The design and application of polymer composites incorporating nanoparticles (NPs) has provided significant benefits to various areas of science, where the incorporation of these nanoparticles can drastically improve the desired properties of these materials in targeted applications. One of the methods that can be used to modify the nanoparticles is the plasma technique. This is a relatively simple, rapid, and dry method that has been used to modify the surface of different substrates. This technique has been successfully used during the last decade for the surface modification of different filler particles, such as; zinc, iron, and aluminum oxide nanoparticles, nanoclays, carbon nanofibers (CNFs) and nanotubes. The aim of this research was to perform a modification of graphene with ethylene plasma to improve the compatibility of the NPs with a polyethylene matrix to obtain a nanocomposite with improved electrical and mechanical properties. In this work, the modification of graphene nanoparticles (GNP's) with ethylene monomer was carried out in a rotating plasma reactor excited by a high voltage source. Graphene nanoplatelets were purchased from Cheap Tubes ©, which were introduced into a rotavapor modified to operate as a plasma reactor under pressure conditions of $6x10^{-1}$ mbar and a rotational speed of 15 rpm, which allows to disperse the graphene during the treatment and facilitates the interaction of the plasma with a greater amount of NPs. A purification of the residual air inside the chamber was carried out to assure an atmosphere of ethylene inside the reactor and the monomer was ionized with a source of high voltage (a power of 135 W). This allows the reduction of operating times and increases the amount of material that can be treated in each batch. For the characterization, dispersion tests were carried out in trichlorobenzene (TCB), X-ray diffraction, Raman spectroscopy, SEM and TEM to observe differences between treated and non-treated GNP's as well as TGA for the thermal properties. Fusion mixing was carried out by extrusion at the conditions of 180 °C and 60 rpm, after which plates of the nanocomposite were obtained by the compression molding technique using heating presses at 210 °C and cooling at 24 °C. The mechanical characterization of the plate showed an increase in the Young's modulus by 40% and the electrical resistivity was reduced by 4 to 6 orders in magnitude with respect to the polyethylene matrix.

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OIM10

CFD Modeling of Plasma Gasification Reactor for Municipal Solid Waste

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The plasma gasification of solid municipal solid waste (MSW) is one of the thermochemical technologies that converts the waste into energy. The waste is exposed to high temperatures to transform the organic compounds into synthetic gas that could be used as power source, fuel substitute or reactive in the bio-fuel production. The inorganic compounds are melted completely and an inert environmentally friendly vitrified is obtained, that could be used like building material [1].

The plasma gasifiers have some advantages against traditional gasifiers, for example, high temperature and heating rates leads to compact reactors, improving its performance and conversion rates. Moreover, all the inorganic residues are processed in a melting chamber, leaving a fully vitrified, strong and resistant to chemical leaching material [2]. On the other hand this kind of technology have some disadvantages like the high initial investment and the high electric consumption of plasma torches [3].

Recently in Costa Rica, the interest on this technology has grown due to the lack of new spaces for landfills purposes, the growing production of MSW, the high organic content of MSW in Costa Rica and the concern of give a better use to the solid waste. The Instituto Tecnológico de Costa Rica (TEC) in order to attend this national problem, develop a series of projects that will culminate in the creation of experimental prototype of a plasma gasification reactor. Currently we are in the phase 2 of the project.

All these aspects as well other are being studied at the TEC, through the development of computational fluid dynamics (CFD) models, defining a prototype reactor with a capacity of 1-2 metric tons of MSW per day, using DC plasmas torches. Variations on composition within the MSW and process conditions will be studied in order to achieve high efficiency and economic feasibility. The CFD models includes mechanical, thermal and chemical aspects of the turbulent reactive flows inside the gasification reactor, with 0-D, 2-D as well 3-D considerations. The experimental phase of the project will be developed soon, taking into account the CFD models results, in order to implement the technology and eventually improving it.

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Tribo-mecanical applications produced by TiAlN films generated by HiPIMS

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High power Impulse magnetron sputtering (HiPIMS) has the capability of yielding highly ionized flux of gas and sputtered materials by applying high power in short pulses to the targets. TiAlN films were deposited using a homemade reactor with two non-balanced magnetrons; co-deposition was produced on a 4140 tool steel AISI-SAE designation. From the process, optical emission spectroscopy was preformed and the combination of voltage pulses and current was measured. Microstructure of thin solid films were characterized by X-ray diffraction and scanning electron microscopy, hardness and friction coefficients were determined.

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OIM12

Signal enhancement in laser-induced breakdown spectroscopy using gated high-voltage pulses

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It is well-known that when the beam of a pulsed high-power laser is focused onto a solid target it produces a plasma. The spectral analysis of the emitted light by means of a spectrometer allows the chemical composition of the target to be obtained. This technique is known as Laser-Induced Breakdown Spectroscopy (LIBS). If the spectral lines are faint, their intensity can be enhanced with the help of a concurrent electrical discharge. This adds energy to the plasma and reheats it thus increasing its emissivity. In this work we demonstrate that the application of a unipolar, square, high-voltage pulse is a convenient way to improve the signal-to-noise ratio and, consequently, to enhance the resolving power of LIBS. The square pulse is obtained from the discharge of a charged coaxial cable. This could be triggered at different delay times (0-10 μs) with respect to the ablation plasma onset. The optimal moment to apply the high voltage pulse was investigated for different voltages and laser beam fluences. The results show that, depending on the energy of the main laser, the optimal time for application of the HV pulse is 300-1300 ns after the plasma onset. It was also found that the signal enhancement obtained is of the order of a factor of 3 for the neutral lines and a factor of 10-100 for the ionic ones.

OIM13

Using Insulation of Porcelain for Glow Discharge Plasma of the DC Planar Reactor

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The confection of electric insulation of porcelain has been more acceptable than using pieces of alumina ceramics because the porcelain can be built more flexible manner. The goal this project is to use electric insulation with porcelain material to encapsulate the electrodes of a planar reactor properly to generate a normal electrical glow discharge between electrodes with DC power supply. The porcelain material is a white color, translucent and waterproof product that presents vitrification property. Porcelain has mechanical resistance and small porosity and milling of the it raw material is classified according a granulometry of the composition of 40% of kaolin, 25% of quartz, 25% of feldspar and 10% of clay which malleability of porcelain is obtained with addition of water. The kaolin is an ore composed of hydrated aluminum silicates, like as kaolinite and haloisite [1,2]. The vitrification process of porcelain occurs inside a oven in which the temperature rate is let increase 1,5 Celsius degrees per minutes until 300 Celsius degree, and after that the temperature rate is adjusted to increase 0,5 Celsius degrees per minutes until 1200 Celsius degrees. This baseline of 1200 Celsius degree is maintained during 12 hours when the porcelain is cooling down inside of the oven during another 12 hours. During this burning process the porcelain loses all quantity of water and change from crystalline phase to vitreous phase, characterized with grains welding. The vitrification process provided to porcelain a little weakly grayish texture and a large hardening because of presence of the silicates. During luminescent plasma discharges was possible identify electron column region. For keeping the stability of plasma was evaluated a sensible parameters conditions like as gas argon pressure and also breakdown voltage. During measurement of a range of pressure versus electric tension was possible study the states of the stability condition of the plasma and plot Paschen's Curves with minimum sparking potential [3,4]. Breakdown voltage V_b is the minimal electric voltage that keeps DC glow discharge with maximum ionization, at point, $(pd)_{min}$, of the product pd of the pressure of gas argon times the gap between electrodes.

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OIM14

Study of laser ablation of levitated water droplets

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Optical breakdown in tridistilled water drops acoustically levitated, was studied by time resolved optical emission spectroscopy and by analyzing the transmittance of the laser pulse energy. Breakdown was induced by Nd:YAG laser pulses of 10 ns with energy of 100 mJ and duration of 10ns, at 1064 nm. In order to obtain a signal related to the plasma and to understand the physical process of the drop breakdown, we place the drop between the parallel plates of a capacitor, where negative plate is connected to ground by a resistor which gives a voltage signal [1]. In this work we analyze the plasma characteristics and we related with external parameters.
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OIM15

Hydroxyapatite coatings on polymers using a Low Energy Plasma Spray (LEPS) system

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The use of polymers in modern orthopedics and tissue engineering represents a big opportunity to overcome the current challenges facing metallic implant technologies, such as the release of toxic metallic ions and particles, as well as the lack of isoelastic property [1]. The latter causes implants to have different rigidity as the surrounding host tissue, causing stress shielding and restricting adequate bone in-growth [1]. Nonetheless, most polymers lack the property of establishing chemical bonds with bone tissue, known as osseointegration [2], which is widely sought in this kind of medical devices. Therefore, implants can be coated with bioactive materials such as hydroxyapatite (HAp) by means of Atmospheric Plasma Spray (APS). This technology is the most widely used for surfacing implants with coatings of high osseointegrating capacity, but unfortunately, it has been primarily applied to metallic substrates, and only a few studies are available on polymeric and composite materials [3].

Consequently, the aim of this study was to apply HAp coatings on polymers commonly used for orthopedics and tissue engineering applications –PEEK, PLA and PVA–, using a custom designed Low Energy Plasma Spray (LEPS) system, equipped with a DC torch in the range of 2-20 kW. Due to the lower enthalpy in the LEPS system, it is expected that it will not degrade the shape, surface condition or chemical composition of the polymers during the process, and still achieve enough energy to properly melt the HAp powder particles. This resulted in a high-quality deposition, comparable to a high-end plasma spray system, particularly for PEEK substrates.

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OIM16

Low-Temperature Plasma Irradiation to Improve Germination and Growth in Seeds of Coriandrum sativum, Lycopersicon lycopersicum, Phaseolus vulgaris and Raphanus Sativus L

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According to the UN Food and Agriculture Organization (FAO), one of the challenges of agriculture in the 21st century, is to produce more food to feed a growing population, using more efficient and sustainable production methods [1]. For this reason, it is necessary to achieve a more effective and rapid production of agricultural products, preferably without involving the use of chemicals such as fungicides and pesticides, which are often harmful to the environment and living beings [2]. Consequently, it is sought the development of new technologies that involve more environmentally friendly and healthier processes to produce plants free of pathogens and with higher growing rates.

Nowadays, germination rate pre-sowing methods are usually performed in order to stimulate the seeds to germinate and grow more quickly. One of the most innovative and promising technologies in this area is the use of Low Temperature Plasmas (LTP), due to its low temperature operation and short processing times, which causes no damage to the seed nor environment. It is known that plasma products (reactive species, electromagnetic fields, UV radiation and others) can affect seed quality, growth and germination [3]. Although the process could be applied to any species, the effects vary, and therefore it is necessary to perform tests to find the most suitable parameters for each agricultural product.

The aim of this work is to present a contrast between untreated and LTP treated seeds of Coriandrum sativum, Lycopersicon lycopersicum, Phaseolus vulgaris and Raphanus Sativus L, at four different exposure times. The purpose is to observe the differences in germination rate, growth rate and seed vigor for each dosage. Results indicate that germination vigor of the seed and the growth rate increased in all the species. The above proves that LTP irradiation on seeds could be a viable pre-sowing method to improve their germination and growth, tackling some of the challenges of modern agriculture.

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Superficially Modification in Graphite via cold plasma treatment of ethylene for the development of thermally conductive polymer composites based on High Density Polyethylene

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In the development of thermally conductive polymer composites the use of metallic and ceramic particles is necessary due they have infinitely higher values of thermal conductivity than the polymers. However, in order to be able to take advantage of all the properties of the reinforcing load, either metallic or ceramic, the presence of an interphase is necessary to favors the interfacial adhesion between the polymer and the filler. Such an interphase, in addition to improving the adhesion, contributes to reducing the interfacial thermal resistance and improving the dispersion of the charge in the polymer matrix, in this way the formation of thermal conduction paths through the composite is promoted.

In this paper, graphite particles were modified via cold plasma treatment of ethylene. This treatment allows deposited an ultrafine coating of plasma polyethylene on the graphite particles. Precisely, this polymer coating deposited superficially in the graphite will act as an interphase when incorporated into a high density polyethylene (HDPE) resin. The graphite was subjected to different treatment conditions in order to determine the most appropriate working parameters. In order to corroborate the presence of the polymer coating (plasma polyethylene), treated and untreated graphite were characterized by various analytical techniques.

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Poster
Session 1

The Morphology and Directionality of Intense Birkeland Currents Surrounding Earth from Global Survey Satellite and GPS Data

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A spaghetti of intense currents have been recorded surrounding the Earth that, at times reach tens of gigaamperes. The directionality and morphology of synchrotron light emitted by the currents have been recorded by mankind over millennia and are now verified by direct satellite observation and GPS ground measurements worldwide. The resulting patterns have influenced symbols on national flags, Mesopotanian, Egyptian, Chinese and Indian artwork as-well-as rock art carved on granite. In correspondence with mankind's data from antiquity, three-dimensional particle-in-cell simulations on teraflop computers show the Biot-Savart merging of currents from 112 distinct currents, converging in pairs to 56 currents, then 28, followed by 14, eventually reaching 4 currents (a quadrupole). The directionality of the synchrotron electrons is from south (Antarctica) to north (Arctic) and in the opposite direction for the heavier ions. While measurements were made on all continents (except Antarctica), following von Humboldt's path, the current's directionality was found to be within two degrees of true south by our survey of the Orinoco River in Venezuela from pristine boulders tumbled together, giving narrow field-of-views. A plethora of examples are given.

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Force-free fields in the solar corona and the identification of solar flare sites

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Solar flares are the result of an impulsive release of large amounts of energy due to the process of magnetic reconnection. It is recognized that magnetic energy is stored in the solar corona due to the slow motion of the footpoints of the magnetic flux tubes in the photo-sphere. By this process, the initially current-free coronal fields evolve to essentially force-free fields since the coronal pressure is relatively unimportant. This fields can be computed from the measured photospheric magnetics fields solving a boundary value problem. When the proportionality parameter α between the current and field ($\nabla\times\boldsymbol{B} = \alpha\boldsymbol{B}$) is constant, the computation is quite straightforward leading to a linear force-free field (FFF). By choosing a well defined flare event we have computed the linear FFF from magnetograms taken from SDO observations. Then, the fields are analyzed to look for potential sites of magnetic reconnec- tion. These are local regions where the magnetic field projection on a certain plane reverses polarity, i.e. where a current sheet or a null-point is present. We found that the location of the reconnecting site turns out to be relatively close to the actual site where the flare originated [1], although this is still a crude result. This was made for other flare events taken from SDO database. To improve on the field description a non-linear FFF is computed in which α is a function of position. This is made using a Grad-Rubin method [2] that computes first the values of α on the whole volume using the vector magnetograms in the photoshere taken from SDO and then uses them to solve the FFF equation. The process iterates the two steps starting from a potential $\boldsymbol{B}$ field until convergence is achieved. The results of these computations will be reported as well as the improvement on the identification of the flare site. The computed configurations will be used in a reconnection model to obtain the reconnection rate and energy release.

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Microwave Brightness Enhancements Inside Coronal Holes

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It has been detected that the radio brightness in the coronal holes is not uniform and in certain regions increases this brightness at 17 GHz. This phenomenom has been observed with the Nobeyama radio-heliograph, located in Japan. The existence of these brightnesses is not explained in the literature. Therefore, the first thing that was done, was to generate maps of the sun from data of AIA to 193 Å to observe the coronal holes, and to delimit them. Once this is done, the coordinates where the coronal holes were located are superimposed on the Nobeyama maps and we observe that the phenomenon exists. It was found that in certain regions within the coronal holes there is a greater than average brightness increase which could be explained by some external heating mechanism. In this work the interaction between cosmic rays and the coronal holes is the proposed mechanism

The shadow of the Sun view by HAWC

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The corona is the outer layer of the Sun atmosphere, and is structured by the magnetic fields that to date have not been able to determine with precision. These fields play an important role in the solar atmospheric physics, but up to now, it has been very difficult the direct observation and measurement of such fields. In order to indirectly estimate the coronal fields, we analyze the deficit of the galactic cosmic ray flux caused by the Sun and its magnetic field, i. e. the "Sun-shadow", recorded by the gamma ray observatory "High Altitude Water Cherenkov" (HAWC), located in Sierra Negra, in the state of Puebla at 4100 meters a.s.l. The Sun-shadow maps allow us to deduce the general characteristics of the coronal magnetic field, this is based on the fact that the affectation of the cosmic rays and therefore the morphology of the shadow, depends on the energy of the cosmic rays and the intensity of the magnetic field. In this work, we present the Sun-shadow maps integrated temporarily by Carrington rotations; the corresponding magnetic configuration of the low corona deduced by the extrapolation of the photospheric magnetic field; and the preliminary analysis of the Sun-shadow dispersion and their temporal evolution.

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P1-6

A Thermodynamic Approach of the ICMEs evolution of speed, travel time and temperature

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Due to their important role in the Space weather, Interplanetary Coronal Mass Ejections or ICMEs have been thoroughly studied in order to forecast their speed and transit time from the Sun to the Earth. In this work, we present an analytical model, derived from the principles of Thermodynamics, that describes the dynamics of ICMEs. The thermodynamic approach has some advantages with respect to the hydrodynamic approach. First, it deals with the energy involved, which is a scalar quantity. Second, since the energy is an additive quantity, one may calculate the work done by the different forces separately and, afterwards, sum all contributions to determine the changes in speed. The latter greatly simplifies the problem and, still, allows us to obtain fully rigorous results. The model takes into account the drag force, which dominates the dynamics of ICMEs and, also, the solar gravitational force, which has a much smaller effect, but it is still relevant enough to be considered. The model derives an explicit analytical expression for the speed of ICMEs in terms of its most relevant parameters, like the mass and the expansion coefficient. We also obtain an analytical expression for the ICME temperature, in this case; we only use two parameters, the initial temperature and expansion index. The model is tested with an ICME identified at three different heliocentric distances (near the Sun, at near 1 *AU* and at 5.3 *AU*) and, also, with 11 ICMEs observed near the Sun and at ≈ 1 *AU*. In both cases, we have a consistent agreement between the theoretical and the observed speed and transit time. Taking the measured temperature values at the Earth, for the same 11 events, we estimate the departure temperatures of these ICMEs.

Automatic identification of large-scale structures related to STEREO spacecraft observations

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From the space weather point of view, the identification and tracking of Heliospheric transient structures, as coronal mass ejections (CMEs) and streamer interaction regions (SIRs), from their creation to their propagation through the interplanetary medium, is a very important issue in terms of space weather, due to the consequences of the interaction of these transient events with the Earth magnetosphere and its dangerous effects on some technological infrastructures. The study of such phenomena is based on the visual identification of large scale transient structures on coronagraph images and the "insitu" observations of instruments on board of spacecrafts like the Solar and Terrestrial Relations Observatory (STEREO). In this work, we use the measured data from WIND and STEREO spacecrafts, specifically, data of the solar wind parameters as speed, density, temperature and magnetic field magnitude, for the period of time between 2008 and 2013. We look for signatures of transient events like CMEs and SIRs automatically in the three spacecraft, besides, we compute the fluctuations and the related wavelet transform of every solar wind variable, finding a good correspondence between the parameters and its related wavelet scales in at least two spacecraft for the events analized. This was compared with a catalog of reported structures and the obtained results confirmed with a with a analysis of cross-correlations.

Tomographic reconstruction of the ionospheric plasma over LISN: Numerical simulations and data fusion

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The purpose of the present study is to assess the capabilities of LISN[2] (Low Altitude Ionospheric Sensor Network) and Jicamarca Radio Observatory's incoherent scatter radar (ISR) system to provide data suitable for accurate tomographic reconstructions of the ionospheric plasma electron density. Using simulated ionospheric profiles, we compare the precision obtained by different numerical methods to perform the linear inversion[1,3] (algebraic reconstruction techniques and regularized approaches), emulating the temporal and spatial constraints of the LISN and ISR data. We also test different geometrical approximations to determine a common volume adequate for a tomographic inversion and some strategies to use ISR and ionosonde data as constraints for the linear inversion as well as for validation of the numerical estimates[4]. The results of this work will be used to design a network of GPS receivers and define an inversion method to complement the measurements done by the Jicamarca Radio Observatory.

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Numerical model of jet formation in the solar atmosphere

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Using numerical simulations, we have shown that jets with features of type II spicules and cool coronal jets corresponding to temperatures of 10^4 K can be formed due to magnetic reconnection processes in a scenario with magnetic resistivity. Two complex magnetic configurations were analyzed. The first one corresponds to the two neighboring loops with opposite polarity (2D model). We studied (i) a symmetric case, i.e. when the magnetic field strength of the two magnetic loops is equal and (ii) an asymmetric case when magnetic strength of neighboring loops is different. In the case (i), with a symmetric configuration excited jets rise vertically, whereas in the case of an asymmetric configuration (ii) the jet shows an inclination, which depends on the magnetic field strength ratio of the two loops and the distance between them. The second magnetic configuration corresponds to a 3D magnetic field, which has a more complex structure, including bipolar regions with a high magnetic field strength at photospheric level. In this case we see the formation of jet-like structures in regions where magnetic reconnection is predominant.

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Studying SEP events using STEREO Spacecraft

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Solar energetic earticles (SEPs) propagate across the interplanetary space with energies of the order of MeVs. Gradual SEP events have been associated with Interplanetary Coronal Mass Ejection (ICME) driven shocks. The proton intensity profile for the gradual SEPs has been associated to the magnetic connectivity of the observer with the solar source of these. Sometimes it can be observed a small intensity peak near the time of the shock passage, this peak is know as energetic storm particle event (ESP). In this work we analyze the ESP events observed with both STEREO spacecraft using proton flux and plasma in situ data as well as remote observations during the period 2011-2014 in order to study their characteristics and its relation with the parameters of the associated shocks.

Coherent π-pulse emitted by a dense relativistic cold electron

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Starting from a three-wave interaction system of equations for free-electron lasers in the framework of a quantum fluid model, we show that these equations satisfy the Sine- Gordon equation. The full solution in space and in time of this set of equations are numerically obtained.

Photodetachment of negative ions in a swarm experiment: Experiment and simulations.

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Swarm experiments in electronegative gases have been extensively studied for its importance on the discharge and formation of plasma processes. The Townsend pulsed technique (TPT) has proven to be a successful and efficient tool to study some of these processes. However, direct information about the species, densities and lifetimes of negative ions formed during a gas discharge can only be obtained from the TPT experiment under special conditions due to its limitations. To overcome this problem an experimental technique based in TPT is presented.

A pump-probe like experiment involving two laser systems was built to study the photodetachment of negative ions produced in a swarm avalanche. The first laser beam (355nm, 3-6 ns, 10 mJ) is used to start the swarm experiment, releasing photoelectrons from the cathode of a pair of parallel metallic plates. The electrons then interact with the electronegative gas while they move within a homogeneous electric field, forming negative ions. A second tunable laser beam (220nm-2100nm) is then directed through the avalanche of negative ions, causing photodetachment. Here, we present the first results and simulations with this method for oxygen (O_2).

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P1-13

Electron drift velocity and density-reduced effective ionization coefficient in pure chlorine.

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Swarm experiments in chlorine gas (Cl2) are remarkably scarce. To the best of our knowledge, only two experimental studies of swarm parameters for Cl2 have been reported. Bozin and Goodyear [1] measured the coefficients α/N, η/N, and $(\alpha - \eta)/N$ in Cl2. Another measurement of η/N was made by Bailey and Healey [2]. They also reported the only known measurements of electron drift velocity (W) for chlorine using mixtures of Cl2 with He. Clearly, there is some controversy among the low-energy plasma community for the reliability of these only available data and, therefore there is a need for new measurements. This lack of data is mainly due to the serious technical challenges for the experiment because of the highly corrosive, toxicity and electronegativity of gaseous chlorine. To solve this problem, we have designed and built a new discharge apparatus based on the pulsed -Townsend method and made of glass walls.
We report on our recent swarm experiment for electrons in pure chlorine and its mixtures with N2. Measurements were made on electron drift velocity and density-reduced effective ionization coefficient and compared with the previously measured and calculated data.

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Non-Maxwellian distributions and their foundation on non-extensive statistical physics

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Although it is common to assume that velocity current distributions of plasma species are Maxwellian, since plasmas are usually not equilibrium closed systems, and particle interactions in plasmas are of long range character, this assumption is seldom fulfilled in practice. Both in laboratory and spacecraft observations, families of distribution functions usually include suprathermal particles, and are best parametrized by the so called κ distributions, or variations of them. Such κ distributions, empirically used in order to fit ion and electron velocity distribution functions in space plasmas, are similar in nature to those obtained starting from statistical mechanics based on non-extensive entropy. The latter may have a clearer physical foundation, although the problem is translated to that of clarifying the foundation of non-extensive entropy. The essential qualitative difference between these families of distributions and Maxwellian distributions is that they have longer tails. The conjecture is that just as Maxwellian distributions can be seen as related to random walk diffusion with constant steps, the new distributions might relate to different kinds of diffusion processes, such as Lévy flights. The purpose of this work is to discuss their theoretical foundations in the context of non-extensive statistical physics [1, 2], as well as some of their consequences, or lack of them, in other fundamental concepts, such as Debye shielding [3].

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Kinetic foundations of relativistic magnetohydrodynamics revisited

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Relativistic plasmas are potentially important for the production of clean energy. Several features corresponding to the transport equations for binary systems are not totally understood. In the present work, we use the relativistic Boltzmann equation in order to establish the balance equations, and we apply the concept of chaotic velocity [1] in the barycentric frame. The formalism is compared to other existing approaches to the problem, emphasizing its advantages.

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Formation of recombining plasma in divergent magnetic field on the linear divertor simulator TPD-Sheet IV

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The divertor design for stable recombining plasma formation should be optimized to handle high heat and particle fluxes. Recently, a Super X divertor (SXD) is planned to accomplish an active neutral particles control to improve plasma confinement in the high-performance plasma for high power and a long pulse operation [1]. Both the divertor target geometry and the magnetic field design to be compatible with the high-performance plasma is one of key significant issues on stable recombining plasma. Although there are a number of papers on the numerical simulation of the SXD configuration [2], very little is known about the experimental simulation of the SXD-shaped target on recombining plasma formation. Design studies about SXD-shaped target in the divertor plasma are not easily understood because three-dimensional geometry of the target in divertor plasma of tokamaks is complex. Therefore, in order to verify more accurate validity, it is necessary to investigate by basic experiments how divergent magnetic field exerts changes on the plasma. To be more specific, it is important to clarify the relationship between recombining plasma and divergent magnetic field. We carried out the experiments for that on the linear divertor simulator TPD-Sheet IV [3]. The divergent magnetic field was performed by individually controlling some stationary magnetic coils current and a magnet core. It was measured the electron temperature and density of the plasma near the target by a Langmuir probe. This probe measurement system is capable of three-dimensional drive. Therefore, a detailed profile measurement of the plasma was possible.

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Complex networks study of the Extended Hasegawa-Wakatani model

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The extended Hasegawa-Wakatani (EHW) equations[1] generate fully nonlinear self-consistent solutions for fluctuations in coupled density and electrostatic potential, for a plasma with gradients in background density and magnetic field strength. Multiscale phenomenology arises naturally, spanning drift turbulence, zonal flows, and their interactions. The transport of charged test particles with finite Larmor radius is typically non-diffusive[2]. Intermittency levels in density and vorticity depend on the magnetic inhomogeneity scale-length, and are linked to morphological changes in the coherent structures that arise from the interchange mechanism[3]. The EHW system is thus a potentially fruitful area for the application of novel techniques for the quantitative characterisation of strongly nonlinear multiscale phenomena. In this work we build a complex network from potential, vorticity, and density fluctuations data obtained from this model, following an approach previously used to study the evolution of sunspots[4]. The goal is to characterise the topology of the resulting network and its possible use as a tool to determine the onset of the turbulent state in the model.

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The versatile high field ultra-low aspect ratio tokamak (HF-ULART) experiment

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A medium-size HF-ULART has been recently proposed [1], with major objective to explore the highest beta limit and pressure possible under the maximum toroidal field(TF), using present day technology and achievements of tokamak fusion research. This is one of pathway scenario for a potential ultra-compact pulsed neutron source(UCPNS) based on the spherical tokamak(ST) concept, which may lead to more steady-state NS or even to a fusion reactor, via realistic design scaling. The major characteristics of this device are: Ro=0.51m, a=0.47m, aspect ratio A=1.10, k<2, δ=0.8, TF at the centre of the vessel B(Ro)<0.4T, Ip<2MA, ne(0)~$1\times20m^{-3}$, Te(0)~1keV, and discharge duration t~100ms. The vessel is spherical, made of SS, and insulated from the natural diverted(ND) plasma by thin(few cm) tungsten(W) semi-spherical limiters. No internal PF coils or solenoid is envisaged. This helps the compactness (relative close plasma-vessel fitting to capitalize of wall stabilization as envisaged in the RULART proposal [2]) and to easy plasma contact via a thin(~2mm) W bored rod over the liquid N_2 pre-cooled CU central stack. The major source of initial heating is provided by Ip generated from RF (e.g. EC and EBW) in combination with transient Coaxial/Local Helicity Injection (CHI/LHI) techniques, as both have been successfully demonstrated in STs. After a very high beta configuration is attained (potentially in H-mode as observed in Pegasus ohmic H-mode in natural divertor configuration using inboard gas fueling) for Ip=0.5MA, B(Ro)=0.1T, q_ψ(Peng)=22, Ti=0.35-0.55keV, ne(0)~$0.3\times20m^{-3}$ and the same geometry, adiabatic compression(AC) technique(*a* and *R*-compression) can be applied leading for short period (several ms) for example: Ro=0.33m, a=0.28m, A=1.17, k=1.6, δ=0.1, Ip=1MA, B(Ro)=0.6T, q_ψ(Peng)=12, Ti=2.5-3.9KeV, ne(0)~$2\times20m^{-3}$. At the peak of AC phase, single cryogenic pellet injection(PI) followed by neutral beam injection(NBI) heating are used for further raising Te and then Ti(0) in density peaked profile target, leading to higher neutron yield, similar in concept to PEP(JET) or super-shot(TFTR) high performance discharges. In this mode of operation the HF-ULART helps the revival of the use of the AC technique in tokamaks, alongside the ST-40(a larger, less compact, and more complex device, currently under construction [3]). In addition, studies in HF-ULART as a UCPNS help also to test the feasibility of similar CNS via the spheromak concept with the AC technique [4]. In addition, in the same vessel, geometries for higher A (e.g. 1.6-2.0) or ITER-like [e.g. Ro=0.51m, a=0.18m, A=2.9, k=1.6, δ=0.24, Ip~0.1MA, B(Ro)=0.4T, q_ψ (95%)=3.0] can be set, leading to a unique bench test for scaling database and testing diagnostics, RF, NBI, and PI, due to large accessibility from LFS/HFS/Vertical(bottom/top).

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Dynamics of the stationary and non-stationary regime observed in Spherical Tokamaks with Plasma Center Column

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We present resistive, zero β, MHD simulations of the formation and sustainment of magnetic confinement configurations of interest in nuclear fusion research. The magnetic configuration was inspired by Spherical Tokamaks (ST), as the NSTX, but the central rod was replaced by a plasma center column (PCC) to obtain configurations similar to the proposed PROTO-SPHERA [1] and Hsu & Tang [2] experiments. This device would confine a hot magnetized plasma inside a simply connected flux conserver chamber with imposed tangential boundary flows. Due current driven instabilities, the plasma self- organizes in toroidal magnetic configurations where a fusion plasma could be confined.

We demonstrate the possibility of forming and sustaining toroidal magnetic configurations in a cylindrical chamber via magnetic relaxation using helicity injection with an imposed external flux [3,4]. We also study the dynamics of the configurations for different elongations and helicity injection rates, which result in quasi-stationary and non- stationary behaviours.

The quasi-stationary regimes were achieved when the cylinder elongation was below 1.4-1.5 and the helicity injection rate was sufficiently low. For these conditions it is possible to sustain configurations with λ ($\lambda = \boldsymbol{j} \cdot \boldsymbol{B}/B^2$) nearly linear in the poloidal flux and monotonically increasing safety factor profiles. When rational surfaces appear inside the plasma, deviations from the linear λ behaviour as well as reversed shear q profiles and magnetic flux disturbances are observed around these surfaces.

Larger elongations have been proposed, in an attempt to increase the value of the safety factor. For larger cylinder elongations and high helicity injection rates, non-stationary regimes with high levels of fluctuations result. This dynamics was not expected based on the analysis made in previous studies, where linear stability theory was employed [5]. We present and analyze in detail this particular results, showing the possibility of magnetic reconnection events triggered by the perturbations.

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Improvements of PXI-Based ECRH Control System on SCR-1 Stellarator

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A small modular Stellarator was designed, constructed and implemented at the *Instituto Tecnológico de Costa Ri*ca with the main goal of providing a tool to carry out engineering and physics research of small size confinement magnetic devices [1]. It has been operational since 2016.

During the first stage, the operation of the SCR-1 was limited to 40% of ECR heating power installed capacity, this article introduces the improvements implemented at the control system that make possible the operation at 100% of heating power capacity. The work also includes an overview about the validation and integration of vacuum pumping, gas injection, ECR heating, diagnostics, and magnetic confinement systems of the SCR-1 as well as the safety systems and data acquisition carry out during the design and implementation of the main SCR-1's control system.

The control system and data acquisition system was implemented on a National Instruments® PXIe® platform. By data flow programming, it was possible to develop different algorithms for the simultaneous execution of four threads during the plasma discharge sequence (device safety, gas injection, data acquisition and plasma discharge), where the primary goal is to implement a robust and secure system considering the integrity and safety of the SCR-1 work team and the hardware involved [2].

Through the implementation the control and data acquisition system, it was possible to perform the first plasma discharge and, therefore, obtain the first results of the device [3].

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Microwave heating scenarios using a full wave code on SCR-1 Stellarator

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The Stellarator of Costa Rica 1 (SCR-1) has been operational since June 2016. This small-size modular Stellarator functions with an aluminum torus shaped vacuum vessel 10 mm thick where R = 0.247 m, <a> = 0.040 m and R/a = 6.2, and containing a plasma volume of approximately 0.0078 m^3. Twelve copper modular coils with 4.6 kA per turn produce a magnetic field strength at the toroidal vertical axis of approximately 43.8 mT. This field is EC resonant at R with 2.45 GHz in the second harmonic (Maximum power 5 kW) [1].

Currently, one objective in SCR-1 is to improve the ECR heating efficiency and to analyze the feasibility of incorporating electron Bernstein waves heating. Relatedly, this contribution analyzes microwave heating scenarios using the full wave code IPF-FDMC [2], which takes as input parameters the experimental electron density and temperature profile [3][4]. This complete analysis takes into account the geometry of the vacuum vessel, the absorption and reflection in the walls, and considers different poloidal and toroidal scenarios. We present the electric field variations of the electromagnetic waves to find the optimum incident angle that is relevant for the conversion to electron Bernstein waves in O-X-B mode. Finally, we propose some strategic places in this Stellarator where an antenna could be located. For the future, it is planned to obtain a deposition profile of the microwave power to indicate the exact position of the UHR region, where the O-X-B mode takes place.

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SCR-2: A Quasi-Toroidally Symmetric Stellarator for Latin America

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The good approximation of toroidally symmetry in the Tokamaks allows them to possess the required confinement of fast particles. It is well known that in order to establish an energy transfer from the fusion products to the bulk plasma, it is necessary to confine the energetic particles for a long time. This allows high plasma temperature to be maintained; which is necessary to sustain a stationary fusion reaction. Stellarators are another alternative to confine plasmas for fusion without needing toroidal currents that lead to plasma instabilities in Tokamaks. In order to achieve this, a fully 3-dimensional shape of the plasma configuration and hence of the coils is employed. As a consequence, the toroidal symmetry of the device is broken and the confinement of fast particles is no longer guaranteed. This is detrimental to a viable fusion reactor, as losses of α particles would damage elements inside the vessel and compromise the heating of the plasma to the temperature required to maintain the fusion reaction. Different equilibrium configurations capable of confining fast particles have been proposed for Stellarators. One of them is the so-called Quasi-Toroidally Symmetric, which gives a Stellarator a toroidal symmetry with neoclassical transport results very similar to the Tokamaks, and with the advantage of Stellarators such as the absence of disruptions. Several Quasi-axisymmetric stellarators (QAS) have been designed (CHS-qa in Japan, NCSX and now QUASAR in the US) but have yet to be completed. The potential benefits of QAS could make them serious candidates for a fusion power plant, but their confinement properties have to be experimentally researched and compared to those of tokamaks and other optimized Stellarator configurations.

Presently, the *Instituto Tecnológico de Costa Rica* possesses the coils geometrical configuration for a QAS called ESTELL (Project cancelled) [1][2], which was calculated and supplied by Max Planck Institute for Plasma Physics (IPP), Greifswald, Germany. This configuration will be used to design the SCR-2 Stellarator, a future two-field period modular Stellarator with an aspect ratio ~5 and formed by 24 optimized modular coils: 6 sets of 4 identical coils assembled in symmetric positions. This contribution shows the MHD equilibrium calculations for SCR-2 (Stellarator of Costa Rica 2) using the VMEC code, specifically in the so-called "fixed boundary" and "free boundary" modes. It is also shown the vacuum vessel and the coil supports preliminary designs, which aim to resize the device and reduce its construction costs.

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Equilibrium simulation for the magnetic confinement of the Spherical Tokamak MEDUSA-CR

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The low aspect ratio Spherical Tokamak (ST) MEDUSA-CR is currently being re-commissioned at *Instituto Tecnológico de Costa Rica*. One of the proposed first tasks is to simulate the magnetic confinement considering the particular coils arrangement of the device. This work presents the resulting shape of the plasma cross-section. MEDUSA-CR main specifications are: plasma major radius $R_o \sim 0.14$ m, plasma minor radius a ~ 0.10 m, toroidal field at the vessel geometrical center $B_T < 0.5$ T, plasma current $I_p < 40$ kA, central electron temperature $T_e(0) < 140$ eV, discharge duration < 3 ms [1]. The free boundary equilibrium solver FIESTA has been used to obtain the plasma shaping and equilibrium parameters. The code works the magnetic confinement for the static Magneto-Hydro- Dynamic (MHD) equilibrium case solving the Grad-Shafranov equation. An *ergodic limiter* was added to the original magnetic configuration aiming to create a limiter with an ergodic behaviour in order to enhance the plasma confinement [2]. The resulting cross-section (without divertor, i.e. *natural divertor*) for the plasma volume is a "bean" shape [3]. The elongation is found to be κ=1.43 and the triangularity δ=0.547. The resulting safety factor profile differs (within the internal half of the toroid) from those of the advanced tokamak scenarios [4]. Further simulations with FIESTA could be used as proof of principle for the effect of the plasma shape on transport and stability.

Acknowledgements: thanks to Geoffrey Cunningham (from Culham Centre for Fusion Energy) for giving us permission to use FIESTA.

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First engineering stage of the Spherical Tokamak MEDUSA-CR

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The low aspect ratio Spherical Tokamak (ST) MEDUSA (Madison Education Small Aspect Ratio Tokamak) is currently being re-commissioned at the *Instituto Tecnológico de Costa Rica,* after it was donated by the University of Wisconsin-Madison, USA. The main characteristics of this magnetic confinement device are described as follows: plasma major radius of $R_o < 0.14$ m, plasma minor radius $a < 0.10$ m, plasma vertical elongation 1.2, toroidal field at the geometric center of the vessel $B_T < 0.5$ T, plasma current $I_p < 40$ kA, $n_e(0) < 2 \times 10^{20}$ m^{-3}, central electron temperature $T_e(0) < 140$ eV, discharge duration is < 3 ms, top and bottom rail limiters, and natural divertor D- shaped ohmic plasmas [1].

The goal of the ST MEDUSA-CR research is to train students and researchers in different engineering and physics areas addressing relevant concepts for spherical and conventional Tokamaks [2]. This will be achieved while taking advantage of the isolated vessel that allows a real-time response in the plasma due to applied external electrical and magnetic fields.

There are several topics to be addressed in the first engineering stage of the MEDUSA-CR. First, the vacuum system design and the corresponding documentation process of the implementation and testing vacuum. Secondly, the design, implementation and testing of a new injection system, entirely developed to accomplish the Spherical Tokamak's requirements. And thirdly, the electric current regulation control of the coils, where the design of the system is shown.

Finally, an overall view of the re-commissioning progress up to date of the ST Tokamak MEDUSA-CR is shown [2,3,4,5,6].

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Development of a Theoretical Model for Uncertainties Evolution in Plasma Rotation Measurements in TCABR Tokamak

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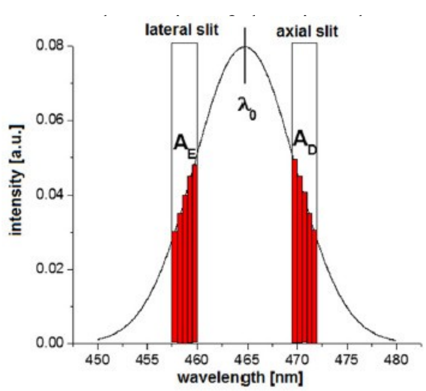
Poloidal and toroidal rotation play an important role in the energy and particle transport and can suppress magnetohydrodynamic (MHD) instabilities in toroidal magnetic configuration systems.

The measurements of temporal evolution of plasma rotation velocity in the TCABR were obtained using a spectroscopic method which is based responding to detection of two different portions of the same impurity emission line which reach different detectors installed at the exit slits of a monochromator. Inside the monochromator, using a semi-transparent mirror, the light is divided into two parts and directed to the photomultipliers located at the exit slits. The lateral exit slit integrates the left part (area A_L in Fig.1) of the spectral line profile and the axial slit integrates its right part, when the plasma begins to move, the center of the spectral line will move to the right or left, changing the ratio $R = A_L/A_A = R(\Delta\lambda)$, which is proportional to the plasma rotation. Here $\Delta\lambda$ is the Doppler shift of spectral line.



In order to estimate the uncertainties in the velocity measurements we built up a theoretical model to describe the diagnostic behavior as function of the diagnostic physical parameters as slit-with, wavelength of spectral line, numerical aperture of monochromator and ion temperature. In this model, the record signal is represented by a function $f(\lambda)$ which is the convolution of monochromator instrumental function $a(\lambda)$ and the spectral emission line contour $g(\lambda)$:

$$f(\lambda) = \int_{-\infty}^{\infty} g(\lambda')a(\lambda - \lambda')d\lambda'$$

In this work we will present the development of above equation and our estimation for uncertainties in velocity measurements.

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Exploring the limits of analytical solutions to the Grad-Shafranov equation with the Solov'ev profile

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While there are several codes which solve the Grad-Shafranov equation, it is sometimes useful to have analytic solutions as benchmarks for such codes, as well as to study some stability problems. Since, for such purpose it is usually necessary to propose the pressure profile and the toroidal magnetic field in such a way that the equation is linear, they are necessarily restrictive. Several papers on the subject have been published, such as the ones by Atanasiu et al [1], and Guazzoto and Freidberg [2], which propose solutions in terms of Hypergeometric or Whittaker functions for a wide range of boundary conditions, relevant to experiments. However, solutions for the Solov'ev profiles, which are the simplest ones can reproduce several features of the experiments, such as the average β poloidal, the average safety factor q^*, the Shafranov shift, etc., when the free parameters are appropriately chosen. This provides a flexible instrument to understand the role of the aspect ratio, elongation and triangularity on the physics of tokamaks with modest resources. This work starts from the solutions proposed by Cerfon and Freidberg for the equatorially symmetric case [3], and stretches them to their limits. The starting point is the set of parameters for the spherical tokamak START, and then we study the consequences of varying the inverse aspect ratio $\varepsilon = a/R_o$, where a and R_o are the minor and major radii at the equator. Similar solutions have also been proposed by Zheng et al. [4], with a different particular solutions for the homogeneous Grad-Shafranov equation $\Delta^* \psi_p(R,Z) = 0$. Here we show there is a more general family of particular solutions, but the satisfaction of the boundary conditions lead to an adjustment of the coefficients in the general solution that lead to the same results.

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On the theories of spontaneous rotation in tokamaks

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It has been observed in several tokamaks that even in the absence of external heating sources, such as neutral ions or RF, there is a spontaneous plasma rotation [1], implying an angular momentum transport which originate in the electromagnetic and plasma transport characteristics of the plasma. In this work we review the experimental evidence of this phenomenon, as well as possible theoretical explanations [2,3]

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P1-31

Magnetic island dynamics in relation to transport barriers in the TJ-II heliac

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The dynamics of magnetic islands is studied in the context of the role they play in the experiments of the heliac TJ-II that show a correlation between MHD activity and transport barriers. The nonlinear island growth is studied in presence of a plasma flow associated with the transport barrier. In previous works it has been found that the presence of a sheared flow reduces the growth rate of the island and is thus stabilizing, when only the modification of the tearing-mode parameter Δ' is considered. However, another effect of the plasma sheared flows is to produce a polarization current in the vicinity of the magnetic island separatrix due to the nozzle effect. The influence of this current on the island stability has been computed for axisymmetric systems [1]. Here, we computed it for a non-axisymmetric geometry, as is the case for TJ-II, and is found to be weakly destabilizing. The proposed model for the island-transport interplay assumes that the sheared flow associated with the electric potential flattening inside a large island builds up a transport barrier. Then the island size is reduced due to a bifurcation in the viscous and electromagnetic torque balance [2], produced by the temperature increase around the island, which reduces collisional effects. This leads to a large rotation that stops reconnection. At some point viscosity reduces the island rotation, destabilizing the tearing mode by a second bifurcation where polarization current plays a role as ripples outside the separatrix produce larger oscillations of the parallel current. This whole process is modeled using the Astra transport code in which we include a turbulence model based on the resistive ballooning mode. Three impurity species of Carbon are also included in order to obtain the emitted radiation that is measured in the experiments by bolometers. In this way we can have a relatively good correlation with the experimental sequences.

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P1-32

Pulsed Magnetic Field Measurement in the Axial Axis of a Circular Demountable Toroidal Field Coil (CDTFC)

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Many plasma fusion machines use Demountable Toroidal Field Coils (DTFC) to produce pulsed magnetic field. This magnetic field require to be measured with high reliability. The most accepted and common method to measure it is by using B-dot coils or commercial Hall probes. Sensor election and design depend on measurement capabilities in mag- nitude and frequency of the pulsed magnetic field. This works present the design and calibration of a B-dot probe inside a typical Helmholtz coil arrangement to measure pulsed magnetic field up to ~0.1 T and ~100 kHz. Commercial Hall probe HE144 is also used, this sensor is able to measure up to 1.5 T with a 0.1 % in linear error working in a frequency range from some Hertz up to ~100 kHz. A 4 turns Circular Demountable Toroidal Field Coil (CDTFC) with L=13 mic- ro-Henrys connects in series with a capacitor bank of C=60 micro-Farads and a limiter resistor R=0.7 Ohms. A high voltage source charges the bank capacitor to 5 kV. Capacitor bank discharges and delivers its energy to CDTFC, thus producing pulsed magnetic field. The pulsed magnetic field measurement in CDTFC axial center axis carry out by set- ting B-dot and Hall probe axial axes parallel to that of CDTFC. Raw voltage data from B-dot and Hall probes stores in a TDS3034 Tektronix Oscilloscope. After signal processing in MatLab, Magnetic Field plots from B-dot and Hall probes are obtained and compared. Typical magnetic fields from 0.01 to 0.1 T are measured. Errors percentage are also measu- red and quantified.

Poster Session 2

Study of the atmospheric-pressure discharge in air

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This paper reports an experimental study of discharges between a metal pin electrode and a tap water cathode in atmospheric pressure air. We applied the diagnosis of optical emission spectroscopy to investigate the characteristics of a plasma jet of air at atmospheric pressure. Discharge characteristics of the active region of the plasma jet, which are critical for applications, have been investigated. The characteristics of voltage and current of the plasma discharge were analyzed and the average plasma power was measured at about 14 kW. The diagnostic has been made by optical emission spectroscopy (OES) using a spectrometer (Model HR2000CG-UV-NIR).Optical emission spectroscopy (OES) was used to obtain species, spatially resolved temperature measurements and electric field estimation for the discharges in air. The formation of OH (A – X) is discussed in the framework of OH (and thus H_2O_2 production) in plasmas in and in contact with liquids. It is argued that electron dissociative recombination of the water ion plays an important role in the production of OH(A) and that the relative intensity of the OH(A) emission may not provide a good estimate of the OH concentration without correction for electron quenching of OH(A).The oxygen present in the air led to a decrease in plasma plume length property due to electronegative oxygen. Atomic and molecular lines of selected plasma reactive species that are considered useful for inducing biochemical reactions such as OH transitions, $A^2\Sigma^+$ ($\nu = 0, 1$) → $X^2\Pi$ ($\Delta\nu = 0$) at 308 nm and $A^2\Sigma^+$ ($\nu = 0, 1$) → $X^2\Pi$ ($\Delta\nu = 1$) at 287 nm, OI transitions $3p^5P \rightarrow 3s^5S^0$ to 777.41 nm and $3p^3P \rightarrow 3s^3S^0$ at 844.6 nm, N_2 (C-B) in the second positive system with $C^3\Pi_u \rightarrow B^3\Pi_g$ electronic transition in the range of 300-450 nm and N_2^+ (B-X) system with negative first electronic transition $B^2\Sigma_u^+ \rightarrow X^2\Sigma_g^+$ ($\Delta\nu = 0$) at 391.4 nm have they have been studied. Our results show that, in the region of plasma, the gas temperature is $T_e = 7.07$ eV and electron density is $n_e = 2.43 \times 10^{15}$ cm^{-3}.

P2-3

Wettability behaviour of polyethylene glycol/polyhydroxybutyrate composites treated by Atmospheric plasma

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The wettability is the tendency of a fluid to spread or adhere on a solid surface[1]. In particular, the biopolymers are used in contact with physiological mediums where wettability has a primordial role, since it is desirable to have hydrophilic materials to enhance theirs biocompatibility[2]. Previous reports have shown that significant changes in the wettability of biopolymers can be achieved through Argon plasma, due to the interaction of the free radicals formed during the plasma treatment[3]. Because of this, in this work a series of polyethylene glycol (PEG) and polyhydroxybutyrate (PHB) composites, which are biocompatible and biodegradable, were treated for 2 seconds with Atmospheric oxygen plasma to study the change in the regime of wettability. The materials were made by means of electrospinning technique (at a controlled temperature of 27° C) and the proportion of PEG and PHB of the composites was 100:0, 80:20, 50:50, 20:80, and 0:100. The wettability of the materials was determined by mean measurements of contact angle (CA). In the first hour after plasma treatment the CA decreased by half in the cases of 80:20 and 0:100 (64 to 32° and 83 to 45°, respectively), while in the case of 50:50 decreased by a third (93 to 31°) and the sample with 20:80 proportion becomes superhydrophilic (from 75 to 0°). Also, depending on the composition of the materials, the stability of wettability changes, being 50:50 and 20:80 the most stable, while 0:100 undergoes a recovery of its CA 168 hours after the end of the plasma treatment. To analyze the changes in wettability of the composites, scanning electron microscopy, differential scanning calorimetry, atomic force microscopy and infrared spectroscopy were performed.

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Analysis and Performance of a Plasma Reactor with the Influence of Addition of Air/Coal Rate

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In this paper, the development of a reactor plasma for generating a warm plasma for obtaining a large volume and high temperature plasma are studied using the addition of 20, 25 and 30% of air-coal mixture into the plasma reactor of a capacity 1 kW.
A thermodynamic study was carried out to determine the temperatures profile in a jet plasma along the chamber, according the air/coal ratio and power consumption. In addition, the coal particle was also characterized in function of their size and velocity. An important effect also existing corresponds to temperature increase due to volatile component released from the coal, passing through the plasma jet. The different modes of operation are of great importance to performance improvement in plasma reactor profitable for GHG treatment. As a consequence, the high temperature in the air and the stable plasma jet, a gas degradation capacity is increased by reducing processes time.
Besides the experimental analysis, the kinetic parameters of the ignition of coal / air mixture, the appearance of a considerable amount of new radicals, the temperature profiles of surrounding in the plasma and ignition chamber wall, have been obtained.
A model based in ANN (artificial neural network) was utilized in order to know the behavior of a temperature of plasma jet. This model allows also simulate intermediate sizes of particle to obtain the optimal temperature in plasma jet, of this manner, the best parameters and conditions of ignitions for the plasma reactor were selected.

Synthesis of Boron-doped carbon nanotubes with DC electric arc discharge

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Boron-containing nanotubes are predicted to behave as semiconductors over a large range of diameters and chiralities and might thus constitute a suitable class of materials for nanoelectronics technology; they could be used, for example, to enhance properties in supercapacitors. There exists a large variety of supercapacitors based on carbon nanostructures as demonstrated in a very detailed work [1].

Specifically, boron doped nanotubes could be prepared by several techniques like a substitution reaction [2] and by electric arc discharge with electrodes prepared by pyrolysis of polymer precursors [3].

In this work, we present some results concerning boron-doped carbon nanotubes synthesized by DC electric arc discharge at 2 kW. The anode is furnished with several mixtures of graphite, catalysts and boron mixtures as follows, 94.8% at. C, 3.2% at. Ni, 1%at. Y_2O_3, and 1%at. B.

After the erosion of the anode by the plasma, the carbonaceous product obtained in the reactor was recollected and characterized with scanning electronic microscopy, X-ray diffraction and Raman Spectroscopy; these techniques confirm the production of carbon nanotubes morphology. In order to determine physical properties of the plasma, optical emission spectroscopy was applied in the spectral range of 300-590m by using a HR4000 of Ocean Optics. From these analyses, temperatures of around 5000K were obtained.

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P2-8

Electrical discharge for the degradation of textile dyes in a continuous flow of water waste

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Water pollution actually is one of the biggest problems to solve, in the industry, about 25 percent of the water is used for textile dyeing processes, and all of these waste waters are discharged into the natural affluent. Several methods has been developed with the purpose of dealing with this problem, with some the disadvantage, for example, the generation of toxic waste due to the added of chemical compounds, low efficiency, high cost of the treatments or large areas to carry out the processes. It is for this reason that the work proposes an alternative for the degradation of textile dyes, through the use of physical processes, carried out by the generation of electric discharges at atmospheric pressure. Unlike previous studies, that show the treatment in a fixed volume, are presented the results of treatments realized in a continuous water flux, with solved dye Basic Red 46 (RB46) at a concentration of 0.1 mM. The system consists of a metal duct, grounded, through which the water flows, and above the water surface 4 electrodes connected to a high voltage, are closed until generate in the liquid-air interface an electric discharge (Corona plasma). Measured flow is of 300 ml/min and a total volume of the sample of 10 liters. The main parameters monitored related to the samples, before and after each treatment, were pH, conductivity, TOC (Total Organic Carbone), COD (Chemical Organic Demand) and temperature; the discharge was characterized by measures of current and voltage, in addition to obtaining optical emission spectra, observing the main active species that are generated in the plasma.

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Optimization of the dyes degradation azo Acid Black 52, triazo Acid Black 210 and its mixture by corona discharge

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The industrial waste water discharges into natural affluent carries serious consequences into aquatic ecosystems, examples of that is the reduction of sunlight needed to photosynthesis processes and the fall in the levels of dissolved oxygen [1]. Of the total water used by industries worldwide, 25% of the water is used by the textile industry; this industry utilizes about 10,000 different dyes and pigments in the world. In order to obtain the degradation of these dyes several methods have been developed, both physical and chemical, recently the interaction with atmospheric plasmas has proven very useful. Corona discharge, a type of cold plasmas, due to their physical characteristics, is able to degrade the dissolved dyes in water. The aim of this work is to evaluate the dyes degradation of AB52, AB210 and its mixture by atmospheric plasma, generated above the interface liquid-air, because of its simplicity. The physical and chemical parameters are monitored to determine the optimum conditions of the organic compounds degradation process.
The results of the interaction of plasma in AB52/AB210 dyes samples are presented by observing the behavior of physical variables such as voltage (2.0 kV) and current (40 mA) during the process (120 minutes), optical emission spectra, temperature, volume and chemical variables such as pH, electrical conductivity (μS/cm), absorbance, TOC, COD, CO_2 production and concentration. The optimum values of pH and concentration of each dye are 3 and 0.5 mM respectively. After 120 minutes of treatment COD and TOC values decrease by more than 80% in the mixture and more than 90 using only one dye; the highest CO_2 production measured in the degradation process was within 30-40 minutes, where CO_2 is produced by the mineralization of the dye. In the optical emission spectrum were identified active species such as H_α, H_β, O*, NO, N_2, O_2^+, N_2^+ and Na. It is possible to conclude that the dyes degradation process by plasma is favorable, under optimal chemical and physical conditions.
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Pulsed corona plasma in glycerin for fuel gas generation.

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Initiation of liquid-phase corona plasma directly in glycerin is proposed as a method of fuel gas production. The use of glycerin is motivated by its excess production, in an unrefined form in the biodiesel industry. Since glycerin refinement is a costly process, its decomposition into gaseous fuels is a possible step to improve sustainability in biofuels industry. Preliminary experimental analysis of decomposition gas products was carried out. The results indicate that glycerin, as a byproduct in biodiesel industry, can be successfully used as a potential source for fuel gas generation.

P2-11

Effectiveness Comparison Between Oxygen and Argon Low Pressure RF Plasma Sterilization, Using a Custom Antenna

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Sterilization of medical devices and equipment is one of the most common requirements in the healthcare industry. Although different methods and equipment have been created and currently commercialized to solve this necessity, the truth is that "conventional" methods – such as autoclave steam sterilization and ethylene oxide (EtO) sterilization– have certain limitations, making the medical devices and equipment sterilization a dynamic research field [1,2], where safety, effectiveness and efficiency must be achieved. One of the most innovative and promising solutions to address these needs is plasma sterilization, which offers advantages such as low temperature, non-carcinogen and non-flammable chemicals and faster processing times, if compared to conventional options [3].

Given that there are only a few commercially available sterilization or decontamination devices based on plasma activity [2], we have designed and manufactured a custom RF antenna for low pressure plasma sterilization. Therefore, the aim of this work is to compare the effectiveness of plasma sterilization using oxygen and argon as antimicrobial active component, using the built in-house equipment. Operational parameters to be considered are exposure time and power. The effectiveness on killing bacteria, specifically S. aureus and E. coli, is measure by counting CFU after treatment, for each set of factors: exposure time, power and gas, using a 2^3 factorial design of experiments. Finally, the analysis shows the most effective combination of antimicrobial component, treatment time and power for each type of bacteria.

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P2-12

Quantification of the atmospheric cold plasma treatment effect on TiO_2 particle settling dynamics.

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TiO_2 is a white inorganic pigment highly important in the chemical, food, cosmetics and paint industries, among others. A problem presented in its industrial applications is that it is insoluble in aqueous and non-aqueous solvents, so additional treatments or polymers should be added to stabilize it in suspension (Diebold, 2003). The main objective of this work is to quantify the effect of the exposure to an atmospheric cold plasma reactor in the behaviour of TiO_2 particles in solution; the application of plasma technologies aimed at particle surface modification of titanium dioxide could be a promising clean-technology able to improve the particles stabilization in aqueous and non-aqueous media by itself (Gilliam et al., 2014). In this work, the sedimentation dynamics of titanium dioxide treated with four different kind atmospheric non-thermal plasmas in a fluidized-bed reactor was quantified in both organic and inorganic liquids, in order to observe if the surface modification had any effect in the settling behavior. The plasmas used were 1) Argon-Acetone mixture 2) Argon-Methanol mixture, 3) Argon-Isopropanol mixture and 4) Argon-Hexamethyldisiloxane (HMDSO) mixture. In order to analyze the sedimentation kinetics, different aqueous suspensions samples were elaborated with these treated particles, sonificated, and monitored through an optical array. The optical array gives information about the amount of light scattered in the sample container because of the particles suspended in the media (Brar & Verma, 2011), and these information was used to graphic the sedimentation kinetic behavior by each sample. Finally, a different non-aqueous solvent was used to contrast the kinetic in an aqueous-media.

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P2-13

Design and construction of a rotary cold plasma reactor for powder and nanoparticles functionalization and superficial chemically modification

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In this work is presented the design and construction of a non-thermal plasma reactor or cold plasma, the objective is to take advantage of dynamic characteristics of a rotavapor and convert it into a rotating plasma chamber to improve the dispersion of particulate material, promote physical contact of the plasma with all treated material to achieve uniform batch modification and homogeneous polimerization of nanoparticles surfaces, in addition it has possibility to treat larger quantities of material (10-15 grams per batch on 1L volume chamber). The reactor has several modifications, including a reaction chamber with diagonal indentations that facilitate the movement of the material being functionalized, the camera has a rotation speed of 5 to 300 RPM and a gases line directly over the discharge chamber in order to carry working gases or reagents directly into the area where the plasma is generated. The system can be excited by a radiofrequency or a high voltage source that was also developed in our laboratory. One of the most outstanding applications of this system is the functionalization or nanoparticles surface polymerization, which is an alternative method to the traditional and complicated chemical processes[1][2].

Also are presented results of surface polymerization of graphene nanoplatelets with styrene monomer in order to improve the compatibility of these nanostructures with a polystyrene (PS) matrix[3] and to obtain electrical conductivity nanocomposites. Characterization of the material treated with plasma and untreated with the techniques of spectroscopy Raman, FTIR, TGA and X-ray are presented. Nanocomposites are fabricated using techniques of solution mixing, melt mixing and solids mixing, surface and volumetric electrical resistivity are evaluated using ASTM 257 and IEC 167 standards, where mixing solids exhibits the best results with electrical conductivities of 8, 11 and 13 orders of magnitude at concentrations of 1, 3 and 10% wt, respectively. In all concentrations and mixing methods, nanocomposites made with treated graphene shows a better electrical conductivity in relation to untreated graphene nanocomposites.

Key words: Rotary plasma reactor, high voltage power source, polystyrene nanocomposites.

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Simulation of a Hyperbolic Field Energy Analyzer

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Energy analyzers are important plasma diagnostic tools with applications in a broad range of disciplines including molecular spectroscopy, electron microscopy, basic plasma physics, plasma etching, plasma processing, and ion sputtering technology. The Hyperbolic Field Energy Analyzer (HFEA) is a novel device able to determine ion and electron energy spectra and temperatures. The HFEA is well suited for ion temper- ature and density diagnostics at those situations where ions are scarce. A simulation of the capacities of the HFEA to discriminate particles of a particular energy level, as well as to determine temperature and density is performed in this work. The electric field due the combination of the conical elements, collimator lens, and Faraday cup applied voltage was computed in a well suited three-dimensional grid. The field is later used to compute the trajectory of a set of particles with a predetermined energy distribution. The results include the observation of the particle trajectories inside the sensor, the comparison of the input energy distribution to the energy distribution of the particles captured by the Faraday cup, and the IV characteristic at the Faraday cup, using the voltage sweep at the conical elements as the abscissa.

Análisis de la densidad de los iones positives y electronegatividad en el plasma del CO y CO2 en una descarga DC mediante una sonda de Langmiur

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La electronegatividad del plasma CO y CO2 en una descarda DC es estudiada empleando los métodos Allan-Boyd-Reynolds (ABR), Balance de corriente (BC), Movimiento Orbital Limitado(MOL) y Potencial Flotante (PF) en ellos se calcula la densidad de los iones positivos usando las curvas I-V. Los resultados obtenidos para encontrar la densidad de los iones positivos y negativos para cada gas son similares en ABR, CB y OML . El método de PF muestra resultados más altos en ambos gases. Mediante la Función de Distribución de Energía de los Electrones (FDEE) se calculó la densidad y temperatura de los mismos. También se pudo calcular la densidad y temperatura de los electrones mediante el crecimiento exponencial de la corriente electrónica y en el Potencial Flotante. En la FDEE para CO y CO2 se encontraron dos tipos de electrones, electrones de alta y de baja energía, los electrones de baja energía son más abundantes. La temperatura del CO2 es más alta en el método de FDEE que en los métodos de la pendiente y el del Potencial Flotante, mientras que en el CO los resultados de la temperatura en los tres métodos son similares. La electronegatividad del CO y CO2 se calculó usando las densidades de los iones negativos y los electrones, en el método del Potencial Flotante la electronegatividad fue de un orden mayor que en los otros métodos.

PALABRAS CLAVES: Plasma electronegativo, temperatura de los electrones, densidad de los iones negativos y positivos.

P2-16

Characterization of SiC and Al_2O_3 Ceramics Exposed to Nitrogen Ions from Inverse-Z Pinch Plasma Discharge

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Silicon carbide ceramics are used for several industry applications, such as structural coatings, ballistic armor, thermal coating protection, high performance mirror substrate, catalyst supports, etc. In this work, dense SiC ceramics with different amounts of Y_2O_3 and Al_2O_3 were exposed to a plasma technique that has recently been used for material treatment called plasma expander. This process is based on the inverse Z-pinch effect. Interaction of the shock waves generated by the expander with ceramic surfaces can change, for example, the wettability and the morphology of sample surface. In this paper SiC and Al_2O_3 ceramics were formed by using uniaxial and isostatic pressing method and sintered, respectively, at 1950 °C and 1600 °C. The SiC ceramics were produced with addition of YAG in proportions of 5 wt%, 7.6 wt% and 10 wt%. On the other hand, Al_2O_3 ceramics were produced with 0.15 wt% MgO. All samples were sanded and polished using the same process. The ceramics received an average of 1440 plasma pulses with discharges made at equal intervals of 20 minutes, using nitrogen as carrier gas. The use of this innovative plasma technique produced significant changes on the SiC ceramics surface. The results obtained from porosity analysis indicate that changes after exposure to plasma occurs mainly on the ceramic surface. The others surface analyzes techniques (wettability, roughness and microscopy) performed on ceramic samples confirm that. After the plasma exposure, the changes on SiC and Al_2O_3 ceramic surfaces are not the same. The alumina ceramic samples were more strength to changes caused by plasma than silicon carbide ceramic samples. This difference can be related to one or more following samples features:

SiC ceramics present an average 300 Ω of electrical resistance, while alumina samples showed 1014 Ω. Therefore, the alumina samples electrical feature tends to concentrate electric charges on its surface, which creates a potential barrier. This electrical shield reduces the kinetic energy of the ions reaching the surface and, consequently, the ablation process on it. SiC ceramics showed higher porous fraction than the alumina samples before plasma exposure. This SiC surface feature allowed ions coming from plasma deep penetrate into the samples. Therefore, the sample hardness decreases due to porosity caused by sputtering process. This porosity increase resulted in lower Vickers values to SiC ceramics after plasma expander exposure.

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Development of a Coaxial-DBD Fluidized-Bed Plasma Reactor Monitored with Laser Light Scattering Signals

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Plasmas are excellent surface modification tools given their exotic chemistry and high reactivity. In this work, the goal is to build a device for the surface modification of powders (mainly Type C Geldart Scale) with a cold plasma treatment in a fluidized bed. The system includes an optical diagnostic based in scattered light detection to monitor the proper distribution of the granules when fluidization is achieved [1,2]. The general system is divided in three parts: fluidization system, plasma generation and characterization by scattered light. The optical diagnostic helps ensure that homogeneous fluidization throughout the column is achieved. The fluidization system consists of a fluidized-bed reactor built to work with cohesive powders. The plasma that modifies the powder is generated by a Coaxial Dielectric Barrier Discharge (Coaxial-DBD), with 12 KVpp and 25 KHz frequency obtained by a RF power supply [2]. The optical system is composed of 16 LED light sources with a narrow emission pattern (10°solid angle), assembled on a straight-line plate. In front of the emitting plate and at 90 degrees, there are two plates with 16 additional photodetectors, also assembled in a straight line. The receiving boards are connected to an NI MyRio 1900 card from National Instruments and sending the data to a Virtual instrument created in Labview for data analysis. The optical arrangement is an application of the Mie Theory of light scattering measurements of the turbidity ratio [3]. To test system performance, different kind and size of powders were plasma treated and monitored during the process with the optical instrument. Results of the system construction and operation with organic and inorganic powders are presented in this work.

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P2-22

Espectroscopia de Plasma Inducido por Láser mejorado con Nano-partículas (NE-LIBS).

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En este trabajo se realizaron medidas de espectroscopia de plasma inducido por láser (LIBS) a muestras de cobre, vidrio y óxido de zinc obteniendo el espectro de emisión característico. Depositando nanopartículas metálicas de cobalto y níquel sobre la superficie del cobre, mediante el secado de un micro-gota de la solución coloidal que contiene tales nanopartículas y realizando el mismo procedimiento de LIBS, se obtuvo un incremento significativo de la intensidad relativa de las líneas espectrales de la muestra. El uso de nanopartículas metálicas sobre la superficie del vidrio y del óxido de Zinc no presentó ninguna mejora significativa respecto a LIBS convencional.

Se presenta un estudio detallado de los mecanismos básicos de NE-LIBS encontrando que las causas fundamentales del incremento en la intensidad de las líneas espectrales están relacionadas con el efecto de las nanopartículas metálicas en el proceso de ablación láser, en términos de una producción más eficiente de electrones semilla y del acoplamiento entre el campo eléctrico proveniente de la luz incidente sobre la muestra y el campo eléctrico inducido en la nanopartícula debido al plasmón superficial.

Se compararon las características del plasma, tales como temperatura del plasma y densidad electrónica, producido por NE-LIBS y por LIBS convencional. La determinación de la densidad electrónica se realizó a partir del ensanchamiento Stark de la línea espectral utilizada y por medio de la distribución de Boltzmann usando las intensidades relativas de especies iónicas y del ajuste de Boltzmann se determinó la temperatura electrónica del plasma, teniendo en cuenta la condición de equilibrio termodinámico local (ETL).

Se utilizó para todo el trabajo un láser de Nd: YAG operando en su longitud de onda fundamental (1064 nm), una tasa de repetición de 10 Hz, con una energía por pulso de 330 mJ y 9 ns de duración.

Simultaneous study of cavitation bubbles produced by laser ablation by photoacoustic and laser-beam-transmission-probe techniques

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Pulsed photoacoustic (PA) technique and laser-beam-transmission-probe (LBTP) were used simultaneously to investigate the temporal behaviour of cavitation bubbles produced by laser ablation of different materials in ethanol. The laser ablation was produced by focussing a pulsed Nd:YAG laser with 1064 nm wavelength and pulse duration of 7 ns into a submerged target in a glass cuvette filled with ethanol. The laser pulse energy used during the experiment was of 60 mJ. First tens of pulses over the same target and liquid were studied in order to accomplish a complete study of the development of the cavitation bubbles during the generation of nanoparticles (NPs) in liquids by laser ablation. The possibility of using both techniques (PA and LBTP) at the same time gave us the chance to study the cavitation phenomena due to the laser ablation process in a wider approach being able to compare the results obtained from each technique. While PA gave us information about the ablation rate per pulse besides the duration of the cavitation process, the optical signal obtained by the LBTP showed us secondary oscillations of the cavitation bubble. Signals from different targets revealed variations in time and amplitude for both signals (PA and LBTP) being consistent with the nature of each material studied. The LBTP technique also gave us information about the behaviour of the cavitation bubbles for different number pulses hitting the targets.

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P2-24

Study of diglyme plasmas by mass spectrometry

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This paper deals with the study of the fragmentation process of $(CH_3OCH_2CH_2)_2O$ diethylene glycol dimethyl ether (diglyme) molecule in low pressure RF excited plasma discharges. The study was carried out using mass spectrometry. The mass spectra were collected by a mass spectrometer operating in the mass range from 1 to 300 amu. Plasmas were generated within a stainless steel cylindrical reactor in a plane parallel plate configuration. 210 mm of internal diameter and 225 mm long, parallel plate electrodes plasma reactor. The chamber is provided with eight lateral entrances, positioned at the mid plane between the electrodes, that may be used for setting optical, electrical and mass diagnostics and the low (mechanical pump) and high (turbo-molecular pump) vacuum systems. The vacuum inside the plasma chamber is monitored by piraniTM (thermocouple) and penningTM (inverse magnetrom) gauges. The turbo-molecular pump is coupled to the chamber through a gate valve and is used for cleanness purposes. The pressure is pumped down to 10^{-6} Torr, being the chamber purged with argon several times before each running of the experiment. The 13.56 MHz RF power was coupled to the chamber through an appropriate matching network. Mass spectrometry allowed one to follow the trends of several chemical species resulted from diglyme's molecule fragmentation for different values of pressure and RF power. The results showed that for a fixed pressure, the increase of the RF power coupled to the plasma chamber from 5 to 45 W produced a plasma environment much more reactive which reduces the population of the heavier species and increases the population of the lighter one. This fact can be attributed to the increase of the electronic temperature that makes predominant the occurrence of inelastic processes that promotes molecular fragmentation. From the point of view of the non-fouling characteristic of the plasma deposited diglyme films the ethylene-glycol structure, e.g., CH_2CH_2O (44 amu), is one the most important structure to be retained within the film composition if one wants to keep its functionality as is already shown in current literature. The experimental results suggest that if one wants to keep the monomer's functionality within the plasma deposited films resulting from such kind of discharges one must operate in low RF power conditions.

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Carbon nanostrucutures deposition on surfaces treated by warm plasma processes

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Atmospheric nitrogen discharges in warm plasma torch were applied to the surface of three different materials: cupper, aluminum and polyester film (polyethylene terephthalate) to modify the surface structure and to improve the adhesion features when containing carbon nanostructures solutions were implanted into surfaces.

The surface modification studies were focused on the morphologic and hydrophilic evolution promoted by plasma exposure. Nitrogen plasmas discharges with minimum energy consumption (around 100 W) were obtained at atmospheric pressure. The chemical characteristics of the plasmas as well as the constant impact of high-energy particles on the surfaces during discharges; yield different types of erosion. The plasma intensifies the crystallinity in the surfaces of the materials and decreases the water contact angles formed on the surfaces as a consequence of the polar groups added to the surface.

The deposition of substances containing carbon nanostructures on the surface of cupper, aluminum and polyester film were realized by an electrospinning technique. The morphology was analyzed by SEM in order to confirm the deposition of carbon nanostructures on the treated and untreated surfaces.

Further work consists in the development of a continuous process to treat a larger area surface and to manufacture supercapacitor prototypes. The study of the substrate and the carbon nanostructures deposition on capacitance values and the capacity to store electrical energy is also considered.

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Post-deadline Posters

Optical and electrical characterization of an Ar discharge, together with an electrode of BN.

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The Argon, is one of the gas most used to make thin coatings. To obtain these coatings, there are different techniques that can be employed, Physical Vapor Deposition (PVD) is one of them, through this technique, and it is possible to obtain different layers, in a thicknesses range of 1 to 10 μm. In PVD coatings, there is a solid material target to be atomized and subsequently deposited on the surface of the material. The main purpose of depositing the layers on a material, it is to protect it, depending on the characteristics and composition of the layer, this layer can protect the material against wear or corrosion. The boron nitride (BN), is a compound whose hardness can exceed 4000 HV, and it is used as a coating, because it is also resistant to different types of wear. In this work, we analyzed the interaction of a boron nitride target (BN) with Argon plasma, to make coatings over AISI steel 1045, previously a thermochemical treated by 80%H_2/ 20%N_2 mixture plasma was applied, the parameters used were: AC density of 0.1 A, 350 V and a total pressure of 3.0 Torr during 12 h. This mixture plasma was characterized using optical emission spectroscopy (OES), the species observed were NH at 336.10 nm, N_2 at 357.69 nm, N_2^+ at 391.44 nm and 427.81 nm, N_2 at 562.11 nm, H_2 at 487.30 nm, 519.64 nm 561.25 nm and 563.48 nm, and Hα at 656.28 nm. The thermochemically treated sample was characterized by X-ray diffraction. The X-ray diffraction patterns show the formation of Fe_4N, Fe_3N y Fe. Subsequently, the sample was treatment with an Ar plasma using a target of BN as electrode. The conditions of BN coating, were: pressure of 3 Torr of Ar, AC density of 0.3 A and 460 V. The coatings times were 5 and 10 h. The Ar-BN plasma was characterized optical and electrical using OES, at a total pressure of 3 Torr. The emission spectrum was measured in a range of 200-1100 nm. The species observed were Ar^+ at 750.51, 763.51, 811.53, 840.82 and 842.46 nm, Ar^{2+} at 664.36 nm, N^+ at 484.73 nm, N_2^+ at 520.10 nm, and B^{2+} at 322.52, 345.13, 369.43 and 378.84 nm. The rotational temperature of the specie N_2^+ was found to be 2000 K. For the BN coated samples, the diffraction patterns of the compounds found are the following: FeB y Fe_2B y Fe.

PD-2

Three-dimensional self-modulated beam dynamics of a non-laminar, ultra Relativistic beam in a non-relativistic cold plasma

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Three dimensional self-modulated dynamics of a relativistic charged particle beam is reviewed within the context of the theory of plasma wake field excitation. The self-consistent description of the beam dynamics is provided by coupling the Vlasov equation with a Poisson-type equation relating the plasma wake potential to the beam density. An analysis of the beam envelope self-modulation is then carried out and the criteria for the occurrence of the instability are discussed thereby.

Electronic Temperature in Microwave Plasma Torch

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This work presents simplicity of construction and operation of a *Microwave Plasma Torch - MPT*. In this case, a cylindrical cavity is mounted with two tamps, and generated by a microwave source of frequency 2,45 GHz and 880 Watts of power are used to produce plasma inside of a quartz tube, mounted coaxially along cavity, with 7 mm of diameter approximately. *MPT* development creates perspective in different areas of knowledge as industrial, medical and scientific applications. The cylindrical cavity excites a dominant electric transverse mode TE_{111} in which surfaces waves transporting energy that reaches up to 100 W/cm^3 levels [1]. The magnetron generator promotes the input energy to plasma in which absorbed power is the balance between incident power and reflected power but it depends on sources losses in the cavity, connection of cavity and existence of other harmonics of microwave. The fact that atmospheric pressure plasma is so close to *Local Thermodynamic Equilibrium - LTE* suggests using equilibrium equations like the Boltzmann equation. The electron temperature is measured by optical emission spectroscopy defined by the ratio $I / \ c$ [2], where I is the intensity observed, and c emission coefficient of continuum. The electronic temperature has been determined by line-to-continuum intensity ratio method according a Boltzmann distribution [3], resulting in an electronic temperature near 5000 K.

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Study of the Interaction of an O_2 Plasma with the Ti_6Al_4V Alloy

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The innovations of the materials used in the manufacture of human prostheses have been studied in their biocompatibility, their mechanical properties, resistance to corrosion, etc. The optimization of the biocompatibility of these prostheses has been done mainly with several coatings. Different techniques have been also used in the application of coatings, including plasma.

In this work, we used the plasma technique in order to modify of the material properties. The oxygen plasma is produced at low pressure, at 1.1 Torr, with controlled parameters of voltage 470 V AC and current of 3.6 mA, for a time of 3 hours. The electron temperature and the ion density were determined using a Langmuir double probe. We used optical emission spectroscopy (OES) to optically characterize plasma. The species observed were: OI at 595.85 nm, 615.81 nm, 665.38 nm, 777.19 nm, 794.75 nm, 882.04 nm, 976.06 nm and 993.69 nm; OII at 229.33 nm, 410.49 nm, 411.2 nm, 411.92 nm, 469.81 nm and 692.07 nm; OIII at 222.35 nm, 385.78 nm and 396.16 nm; OIV at 245.9 nm, 323.82 nm and 334.56 nm; OV at 412.39 nm and 559.79 nm.

The scanning electron microscopy (SEM) technique was used, to study the morphology and concentrations elements. As well as X-ray diffraction (XRD) technique to determine the crystalline phase produced by interaction of the oxygen plasma on the surface of the Ti. The results obtained from the X-ray diffraction, present a phase identified as rutile phase of Ti, which may be formed for the plasma interaction with the Ti_6Al_4V alloy surface.

PD-6

Comparing Langmuir Probe I-V Characteristics of Different Probe Radius in Maxwellian Ionospheric Plasma

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This research paper focuses on the study of Spherical Langmuir Probe I-V characteristics in Maxwellian space plasma. This work is conducted using computational techniques to create the exact plasma conditions of the experimental testing environments. The investigations address the development of a technique to model Maxwellian plasma. Three different sized Langmuir probes has been designed theoretically for ionospheric temperature 0.5eV, with the help of computational techniques; I-V traces produced to analyzed the plasma parameters. The variation of floating potential due to probe size is clearly depicted. A manifest trail in the I-V curves is the bump that occurs right after the floating potential. This feature in the transition region affects ability to determine the electron temperature, ion saturation current and plasma potential.

Keywords: *Langmuir probe, I-V Characteristic, Maxwellian plasma, Probe dimension*

Measurement and modeling of DC currents collected by a RF biased electrode in ALINE

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Plasma biasing due to RF sheaths near ICRF antenna structures lead to negative DC current collection by the antenna structure. Under certain conditions, it is possible to find positive DC currents. This positive DC current is a result of improved ion mobility and larger wall flux tube surface areas. ALINE is an experimental device that focuses on characterizing RF sheaths near ICRF launchers by a creating a fusion device SOL – like region. Ion cyclotron resonance heating (ICRH) is a vital external power coupling method in fusion devices, but it is adversely affected by DC current collection in biased RF electrodes, which cause structural damage and hamper diagnostics, thus creating the need to better understand RF sheath physics. ALINE operates in a discharge configuration in which a magnetic field is nearly parallel to an antenna and perpendicular to a wall cathode in the reactor chamber. The relationship between this collected current and the magnetic field strength, neutral gas pressure and RF power is studied. Results indicate that a current reversal can occur depending on these three parameters. Models are developed using equivalent impedance circuits from capacitively - coupled plasma discharge theory and RF double sheath analysis.

Work done at the Institute Jean Larmour of the University of Lorraine.

Micro plasma based surface modification of ZnO-Epoxy-Graphene flexible thin films

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Lead free ZnO-Epoxy-Graphene based electro-active nano-composite thin films were fabricated using solution based processing, where the volume fraction of the ZnO phase was held constant at 40%, while the volume fraction of the graphene was varied from 0.1% - 2%. Both stable and pulsed corona discharge was used to treat the surface of the thin films towards modification and enhanced surface bonding characteristics through modification in surface energy. The dielectric constant (ε'), dielectric loss tangent (tan δ) and piezoelectric strain coefficients of the samples were measured, and compared as a function of the plasma I-V characteristics. The impedance and dielectric spectra of the composites were recorded over a frequency range of 100Hz-20MHz. The fractured surface morphology and distribution of the phases were observed with the aid of Electron Dispersion Spectroscopy (EDS) and a Scanning Electron Microscope (SEM). The variation in surface bonding characteristics of the thin films is characterized using the dielectric and electro-active properties of the composites.

A study on axisymmetric toroidal Taylor states

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While the qualitative behaviour of Taylor states in Reversed Field Pinch devices can be described by solutions for the force-free-field $\nabla\times\boldsymbol{B} = \lambda\boldsymbol{B}$ for a straight cylinder [1-3], a more accurate description can be obtained with axisymmetric toroidal solutions, such as those proposed by Cerfon and O'Neil [4]. This may be particularly important if the inverse aspect ratio of the torus $\varepsilon = a/R_o$, where a and R_o are the minor and major radii respectively, is increased, which may be important if more compact fusion devices are to be developed. The purpose of this work is to study the influence of ε using a simplified version of such solutions. Namely, how magnetic energy and magnetic helicity can be affected, and how this may influence stability properties.

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PD-10

Review of the dynamics of plasma expansion in pulsed laser ablation plumes

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Pulsed laser deposition is used for nanoparticle synthesis The presence of the laser initiates complex dynamics that influence the whole process: plasma generation, its formation and its expansion. The main approaches are based in magnetohydrodynamics and plasma kinetics, with several methods involving those two lines of study. We aim to review the different methods that are currently being applied to the study of the dynamics of this particular plasmas, with particular attention to the characteristics of the hydrodynamic expansion that could lead to shockwaves in the plasma produced in pulsed laser ablation.

PD-11

Burn control of a fusion reactor using a fuzzy logic system

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The fuel burn in a fusion reactor has to be kept at a nearly constant rate in order to have a steady power exhaust. Here, we develop a control system based on a fuzzy logic controller that adjusts external parameters to keep the plasma temperature and density at the design values of a reactor of the characteristics of ITER. The control parameters chosen are the D-T refueling rate, the auxiliary heating power and a source of neutral helium. We use a fuzzy controller of the Mamdani type that uses a number of membership functions appropriate to produce a response to parameter deviations that minimizes the response time. The inference rules are determined in a way to provide stabilization to all perturbations of the temperature, density and alpha particle fraction. The dynamical response of the reactor is simulated with a 0D model that uses confinement times provided by the ITER scaling. We show that the system is feedback stabilized for a large range of parameters around the nominal values. The recovery time after a departure from the steady values is of the order of one second. We compare the results with another control system based on neural networks that was developed previously.

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