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Energy for the Future
F. Wagner

Energy is gradually getting a rare commodity on one hand and the consequences of burning fossil fuels may lead to major changes of our climate on the other. Physics plays a crucial role in the improvement of established energy technologies but also in the development of new low-carbon sources. Electricity is the most versatile form of energy in a technical context and plays a specific role in the operation of our economies and societies. In my report, I will introduce the energy situation in Europe with material developed in the frame of the Energy Group of the European Physical Society with concentration on electricity. I will try to elucidate the role physics can play in photo-voltaic systems, in saving measures, in nuclear fission and in nuclear fusion. Photo-voltaic systems develop toward higher efficiency, the use of lower-cost materials and the better integration in the existing periphery are major development steps. The application of microelectronic technology and the use of electricity allow saving energy in many areas, housing being possibly the most effective one. Fission develops the Generation IV systems with higher safety, other fuels like Thorium and with concepts to transmute fissile material. Fusion does the step now to the first fusion reactor, ITER, to be built in France. Finally, in a more personnel note, I will comment on some energy related political/societal issues.

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Energy and Sustainability
Cayetano López

The present structure of the global energy supply depends strongly on the fossil fuel consumption. According to the BP Statistical Review, coal, oil and natural gas represent 88% of the commercial primary energy. But the concentration of some of these fuels reserves in a few countries, their intrinsic scarcity and the environmental effects derived of their use make this energy structure highly unsustainable. Therefore, the change towards a more sensible energy supply scheme requires to decrease gradually our dependence on fossil fuels and to increase the contribution of other sources, that is, renewables and nuclear. Both technologies, renewables and nuclear, complement each other and are a reasonable option for the future. I discuss, in my presentation, some of the problems related to the deployment of renewables, with a specific reference to the Spanish case, as well as the way nuclear fission energy is facing its potential development, with a specific mention to the fourth generation reactors. In the long run, nuclear fusion energy must take a significant part in the combination of energy sources we will need when the present prevalence of fossil fuels is no more possible.

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The ITER Project
O.Motojima

ITER is a thermonuclear fusion test reactor designed to demonstrate the feasibility of the DT fusion reaction, and aiming to produce 500MW of thermal output from a burning plasma in 2027. Under these conditions, the plasma, which has a high temperature of 10keV and a density of 1020m-3, shows strong nonlinearity and turbulence. Therefore, to realize this target, extensive integration is necessary in both the science and technology areas - a large budget is also a necessity. For these reasons it is thought that humanity will have only a single chance of building such a test reactor.

The basic document of the ITER project is the Baseline, which has finally been approved by the ITER Council on 28 July last summer, and following this the ITER project has moved into a new era of construction. The Baseline is composed of the scope, schedule and cost of ITER. Scope is highlighted in three points;

• Plasma Performance: (1) Q≥10 pulsed operation, to achieve a significant fusion power amplification with an output power of 500MW in inductively driven plasmas; (2) Q≥5 steady-state operation, aiming at the demonstration of steady-state operation by non-inductive current drive;

• Engineering Performance and Testing: to demonstrate the availability and integration of technologies essential for a fusion reactor (e.g. superconducting magnets and remote maintenance).

The machine completion and the first plasma are expected in November 2019, while the target date for the commencement of DT operation is March 2027. Most of the components for ITER will be provided “in-kind” by the Members through procurement agreements. At present, the critical path for ITER involves the design completion of the superconducting magnets, vacuum chamber and cryostat. In relation to cost containment, the major issues are additional direct investment (ADI), which typically includes in-vessel coils (VS coils, ELM control coils), cold tests of superconducting coils and so on, and spares, which are strongly linked to the success of quality control. We are in close collaboration with the Domestic Agencies of the 7 Members to finalize designs, solving the necessary issues to take the ITER project forward.

At the Cadarache site, cranes, earth scrapers and power shovels have moved onto the platform. Work has begun on the tokamak pit and on the site of the future ITER Headquarters. Concrete is being poured for the pillars of the building where PF Coils will be assembled. The project's sizeand scope are now clearly visible to all as we strive to achieve the goal of “Bringing a Sun to Cadarache”.

The presentation will provide an excellent opportunity to present the new status of the ITER project from both the scientific and technological points of view.

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ITER y Fusión: experiencia de licenciamiento de una nueva física y tecnología nuclear

C. Alejaldre

Por su potencial medioambiental, económico y razones de seguridad, la fusión nuclear de núcleos ligeros es una de las escasas opciones posibles para suministrar energía a largo plazo y de forma masiva a la creciente población mundial. El espectacular progreso realizado mundialmente en la comprensión de la física subyacente en los procesos de fusión y en la tecnología para implementarlos ha impulsado la construcción de un experimento a escala mundial, ITER, cuyo objetivo es demostrar la viabilidad científica y tecnológica de la fusión como nueva fuente de energía.

Aunque es un proceso nuclear, la física que controla la fusión y muy particularmente el estado llamado plasma en el que se encuentra el combustible de fusión, así como la tecnología necesaria para hacerla viable energéticamente hablando, es totalmente diferente de la utilizada en los reactores nucleares en funcionamiento que están basados en la fisión nuclear, por lo que el licenciamiento de ITER, que sin duda será inevitablemente un modelo para las futuras plantas de fusión, no tiene precedente alguno en el mundo.

En esta charla se presentarán los aspectos científicos y técnicos que están siendo discutidos con el Consejo de Seguridad Nuclear Francés para la demostración de seguridad del proyecto ITER para las personas y el medioambiente.

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The Global Energy and Climate Challenges: Research and Development at Lawrence Livermore National Laboratory

Tomás Díaz de la Rubia

In the current policies scenario discussed in the most recent World Energy Outlook (2010) published by the International Energy Agency, world primary energy demand is expected to grow by 44% relative to 2008 by 2035. In this scenario, the long term atmospheric concentration of green house gases (GHG) approaches 1000 ppm resulting in a concomitant average global temperature change eventually exceeding 6 ^{o}C. Providing for the world's energy demand while stabilizing CO_2 concentrations to 450 to 500 ppm is expected to limit the risk of significant climate change but will require an energy technology revolution that includes large scale decarbonization of the world's energy supply and massive improvements in energy efficiency.

In this talk, I will discuss ongoing Research and Development activities at Lawrence Livermore National Laboratory in the areas of climate change and energy technology development. I will start with a brief description of the activities of the Program for Climate Model Analysis and Inter-comparison, an effort devoted to comparing and analyzing all of the world's climate codes, and will provide a brief assessment of the science of what we know and what we do not know about the sources of climatic change and the projections for the future. Meeting CO_2 targets and clean energy goals by 2050 requires accelerated development, prototyping, and deployment of new, competitive, low-carbon energy technologies. Business as usual will not do. In the second part of my contribution, I will describe two approaches to energy technology development underway at LLNL. On the one hand, LLNL is strongly focused on the use of High Performance Computing and Simulation to accelerate the development and commercialization of evolutionary clean energy technologies. I will show examples of where simulation-based design is helping improve energy efficiency, optimize the forecasting and utilization of wind power, and enable Smart Grid of the future. In addition, LLNL is strategically positioned through the advances and progress at the National Ignition Facility to help enable the development and commercial deployment of Inertial Fusion

Energy. The NIF is expected to achieve thermonuclear ignition and burn of at DT fuel mixture before the end of 2012. As we make progress towards this physics milestone, we are also conducting a detailed assessment of the technology requirements and R&D path required to transition from laboratory fusion to commercial scale power production. I will discuss some of the recent progress on the path to achieving the fusion milestone as well as some of the ongoing plans and design concepts for Laser Inertial Fusion Energy.

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The EURATOM Fusion Programme
Serge Paidassi

In the overall context of the EU 2020 strategy, and more specifically of the Innovation Union flagship initiative and of the Strategic Energy Technology Plan to invest in the development of low carbon technologies, the Commission is preparing a proposal for the EURATOM Fusion Programme to succeed FP7 and to be implemented under the Common Strategic Framework until 2020.

The status of the current EURATOM fusion programme centred on the EU contribution for ITER construction through the F4E Joint Undertaking and accompanied by activities in the Fusion Associations and under EFDA including JET exploitation will be recalled.

An overview of the strategic orientation and roadmap envisaged for the future EURATOM fusion research and innovation activities will be presented, focusing on:

- ITER construction;
- Securing successful ITER Operation;
- Laying the foundations for fusion power plants;
- Promoting innovation and increasing EU industry competitiveness; and
- Preparing the ITER generation of researchers and engineers.

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The EFDA Programme
Francesco Romanelli

A fast realization of fusion as an energy source requires an aggressive programme aimed at the qualification on ITER of the burning plasma regimes of interest for DEMO around 2030, the start of the DEMO engineering design activity at the shortest possible time in order to allow the start of DEMO construction before 2030 and the development and qualification of the materials and technologies of interest for a fusion reactor for their test in DEMO.

On the time scale of the ITER construction this requires an adequate preparation of the ITER exploitation through the European accompanying programme, in order to obtain a full scientific return out of the investment in ITER, and to lay the foundation for the Power Plant to make full use of the expertise arising from the ITER construction. This calls for an increased integration of the European Fusion Programme.

The EFDA programme is devoted to the accomplishment of these goals through the collective exploitation of the JET experiment, the coordination of selected ITER relevant physics activities in the Associations and the development of the Power Plant Physics and Technology activities.

This talk presents an overview of the EFDA programme and discusses the way in which EFDA can adequately respond to the challenges of the ITER era.

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Computación y Sociedad
Alfonso Tarancón Lafita

Hace unos años se creo la Unidad Mixta entre el Laboratorio Nacional de Fusion del CIEMAT y el Instituto de Bio-computación y Física de Sistemas Complejos, para aprovechando los conocimientos de ambas partes, realizar simulaciones intensivas del Plasma en reactores de Fusión.

Impulsados por las colaboraciones e importantes resultados obtenidos pusimos en marcha dos nuevas iniciativas, que se han convertido en sendos proyectos de investigación. La visualización de los resultados obtenidos en la simulación de plasmas en el stellarator TJ-II (en operación en Laboratorio Nacional de Fusión-LNF, CIEMAT), en concreto de las trayectorias de partículas y de los perfiles de choque contra la cámara de vacío, puede ser enormemente mejorada utilizando sistemas de visión en 3D. Además de mostrarse útil para los investigadores, estos sistemas tienen un enorme atractivo para el público no experto, ayudando a una mejor comprensión de fenómenos físicos complejos. Por ello y tras los primeros sistemas para visualizar los reactores de fusión, hemos desarrollado aplicaciones para visualizar también materiales magnéticos, proteínas, sistemas didácticos, etc. En concreto hemos modelado el reactor de fusión nuclear ITER donde puede visualizarse el flujo de partículas dentro del mismo. También usando Dinámica Molecular puede verse el comportamiento de la ventana (de Diamante o Silicio) en ITER, y como se comportan los átomos de tritio al intentar atravesarla.

El segundo proyecto derivado de la investigación en Plasmas, ha sido Ibercivis. En sus origen (Zivis), desde la Unidad Asociada LNF-BIFI se pidió a los ciudadanos de Zaragoza que prestaran (vía Internet) sus ordenadores para realizar simulaciones del plasma: cada ciudadano simulaba el comportamiento de una partícula dentro del reactor. El éxito fue tal, que posteriormente hemos lanzado una iniciativa similar en toda España, y a la que se han ya otros países.

Los ciudadanos prestan desinteresadamente sus ordenadores, que se conectan por Internet a nuestros ordenadores centrales, donde tenemos un gran stock de trabajos preparados por diferentes grupos de investigación, además de en Fusión, en propiedades magnéticas, estudio de proteínas, desarrollo de fármacos, etc. Este proyecto tiene pues dos componentes con un peso similar: por un lado dota a los científicos de miles de ordenadores donde ejecutar sus trabajos y por otro permite establecer puentes entre los investigadores y las personas que ceden sus ordenadores, para acercar la ciencia a la ciudadanía.

Computer Science and Society

A few years ago a Joint Unit was created between the Laboratorio Nacional de Fusion, CIEMAT and the Institute for Biocomputation and Physics of Complex Systems of the University of Zaragoza. Its aim was to perform intensive simulations of plasma in fusion reactors capitalizing on the knowledge of both of the centers.

Driven by the collaborations and significant results obtained, we launched two new initiatives, which have become two separate research projects.

Results obtained in plasma simulation in the TJ-II, namely the trajectories of particles and profiles of collision with the vacuum chamber, can be greatly improved by using 3D vision systems. Besides being useful for researchers, these systems have an enormous appeal for the public, helping them to understand better the complex physical phenomena. That's why, after visualizing the first fusion reactors, we have developed applications to visualize also magnetic materials, proteins, training systems,etc. In particular, we modeled the ITER reactor and the flow of particles within it can be seen in real time. Also using Molecular Dynamics the behavior of the window (diamond or similar) may be seen in ITER, and how tritium atoms behave trying to get through it.

The second research project has been Ibercivis. In its origin (Zivis), Zaragoza's citizens were asked to lay (via Internet) their computers for plasma simulations: every citizen simulated the behavior of a particle inside the reactor. After the great success achieved, a similar initiative was launched in Spain and has been spread among other countries. Citizens selflessly lend their computers, which are connected by Internet to our central computers, where we have a large stock of works prepared by different researching groups (in addition to Fusion, magnetic properties, the study of proteins, development of drugs, etc…). This project has two similar components: on the one hand it gives scientists thousands of computers on which they can run their jobs and on the other hand it builds bridges between researchers and those lending their computers, so science gets closer to citizenship.

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Plasmas in Solar Physics
Fernando Moreno-Insertis

Our star, the Sun, is composed of very hot gas, with temperatures ranging from 15 million degrees at its center to about 5000 degrees at its surface. The gas in the Sun is ionized, and magnetized. Therefore, it must be studied using the branch of physics called *plasma physics*. The magnetic field shapes its atmosphere and turns the Sun into *an active star*, in which gigantic eruptions (called flares and coronal mass ejections) take place. Those eruptions are important not only for the Sun itself: their effects (microscopic particle emission, ejection of huge amounts of mass and magnetic field) are felt in the interplanetary medium and, in particular, in the Earth. When a coronal mass ejection impacts on the Earth, it deforms our own magnetic field, injects charged particles into the Earth's magnetosphere and can cause serious disruptions to satellites, electric installations, communications, etc.

Understanding how the Sun works (its physics, its evolutionary patterns on short and long time scales) requires careful observations and modeling. In the past 30 years great advances have been achieved in determining the complicated radiation and plasma physics phenomena operating in the Sun, leading to the fascinating structures observed in it (like the convection cells and magnetic networks, prominences, sunspots). These advances have been fostered by the breath-taking pace of improvement of the computing and modeling capabilities, by the large amount of recent space missions devoted to the observation of the Sun, and by the installation (in particular in the Canary Islands) of revolutionary solar telescope instrumentation. Spain is playing an important role in this endeavor, with world-leading initiatives in solar research and instrumentation.

In this lecture, a review will be provided of the current understanding of various solar structures, of solar eruptions, and the interplay between the matter and the magnetic field in our star.

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Gravitational Plasma Engines
Ana I. Gómez de Castro

Last generation telescopes are providing amazing images of collimated beams or jets being ejected from black holes and proto-Suns. These jets may reach velocities as high as 99% of the speed of light when ejected from the vicinity of black holes and carry mass flows of a solar mass per year. The physical composition of the jets, their thermal structure, the mechanisms for jet acceleration and ejection are a fundamental part of astrophysical research.

Jets are plasma beams fed by the transformation of gravitational into mechanical energy. Gravitational energy is stored in accretion disks
and then transformed into mechanical power by a combination of magnetic, radiative and centrifugal stresses.

Disks are formed whenever matter with a highly intrinsic angular momentum is attracted by a source of gravity AND there is a privileged plane for the mass storage. Accretion disks are gas disks able to transport angular momentum through, thus channelling the matter infall onto the source of gravity.

In this conference, the various types of accretion disks, the theories on disk formation and angular momentum transport will be reviewed. The current understanding on how jets can be generated from the inner area of accretion disks and the role of magnetic fields in this process will be discussed as well as the impact of the jets in the disk evolution.

Astrophysics, provides a unique chance to study this type of engines and their impact on the evolution of the interstellar an intergalactic medium. Jets also carry fundamental information on the structure of the inner region of the accretion disks. In black holes, they reveal the properties of the matter close to the events horizon. In proto-Suns, they inform on the physical conditions of the habitable zone in young planetary systems.

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Turbulence in Plasmas
Volker Naulin

Understanding and control of turbulence is one of the great outstanding scientific challenges. Plasma turbulence is responsible for the observed increased losses of energy and particles from confined plasmas. Turbulence is thus one of the root causes why developing a fusion power plant has proved such a difficult endeavor.

The beauty of plasma turbulence lies within its complexity and the many different effects that it exhibits, besides enhanced transport. Magnetised plasma turbulence shows the buildup of gradients, so-called pinch effects, leading to accumulation of particles or momentum in the plasma core. At the edge of the plasma the ability of the turbulence to shape ordered structures on scales larger than the typical turbulence scale has become obvious with the arrival of fast visual cameras, which are able to visualize these phenomena. Such organized structures, filaments, pose engineering problems of their own to the construction of fusion devices.

Strangely enough plasma turbulence is also presumed to be a key player in the development of regions of reduced transport, transport barriers, where the barrier appearing at the plasma edge provides the basis for the basic operating scenario for fusion devices, the H-mode, or high confinement mode. This allows for ITER, the fusion reactor under construction in southern France, to be build in the present size.

Thus good progress has been made in the last years in understanding plasma turbulence. New ideas for influencing and controlling turbulence are being developed and demonstrated, but the amount of open questions remains a challenge. Where answers have not been found yet, we have, however, progressed to more precise questions, a necessary prerequisite for the development of understanding, which will enable us to make the best use of this emerging energy technology.

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A complex approach to plasma dynamics: from Fusion to Earth and Astrophysical Plasmas

Raúl Sánchez

In nature there are many systems which appear to exhibit some form of self-organization from which a priori unexpected structures and dynamical behaviors emerge. These are unexpected specially when examined in the light of the physical mechanisms that govern each of the individual elements that form the system. Several common ingredients seem to be needed for complex dynamics to emerge: strong nonlinear interactions between many independent elements or negrees of freedom, the presence of instability thresholds, fluctuations and external drives for the system. Examples of these systems are forest fires, earthquakes, sandpiles, and even aspects of economics and society itself.

Similar self-organized behavior is also found in plasmas, a state of matter similar to gas in which a certain portion of the particles are ionized and extremely common in our universe. Although the underlying equations governing plasmas are relatively simple, plasma behavior is extraordinarily varied and subtle as a result of their extreme susceptibility to the presence of electric and magnetic fields. Plasmas lie in some sense on the boundary between ordered and disordered behavior and cannot typically be described either by simple, smooth, mathematical functions, or by pure randomness. The spontaneous formation of interesting spatial features and complex dynamical behaviors over a wide range of length and time scales is one manifestation of plasma complexity. Examples of emergent, complex phenomena will be presented from a variety of plasmas, ranging from fusion to astrophysical plasmas. At the same time, some of the concepts and techniques first originated within the study of complex systems that have been used to attempt to understand them will also be discussed.

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Tecnologies for Nuclear Fusion
Joaquin Sánchez

The operation of a fusion reactor implies, in addition to the understanding of the complex behaviour of the high temperature plasma, the use of a broad set of leading edge technologies.

If we focus on magnetic confinement systems, first we need to develop gigantic superconducting coils , working at temperatures between 1.5 and 4ºK, which will provide the confinement of the plasma, but also we will need the systems to heat the plasma up to the required temperatures of 15-30 keV (1keV being equivalent to 11,000,000 ºK). Those systems, based on the launch of RF power or the injection of accelerated particles will initiate the fusion reaction and complement the internal fusion-generated heating when the plasma reaches ignition.

In order to get information on the properties of the hot plasma and control its parameters, we will need a number of diagnostic systems. This will mean a tremendous challenge, involving many different technologies trying to extract information from each portion of the electromagnetic spectrum.

Those plasma related technologies, have been developed during the last decades of magnetic fusion research and still will require a significant effort for their application in future reactors. But, in addition, we will need to develop a number of nearly new technologies, oriented to the nuclear aspects of the fusion reactors. We will need new materials able to withstand the thermal loads on the first wall and the overall 14 MeV neutron irradiation. Also, sophisticated remote handling systems will be needed for the maintenance of the internal elements of the reactor. Finally it is worth to mention one of the most complex systems to be developed for commercial fusion plants, the "breeding blanket", which will be the component responsible for the shielding of the coils from the neutron irradiation, the extraction of the power to the heat exchangers, and the regeneration of the tritium using Lithium as input material.

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Industrial Application of Plasmas
U. Czarnetzki

Plasmas are complex systems of free charged and neutral particles. In most industrial applications advantage is taken of a strong non-equilibrium property found in so called low-temperature plasmas. Here, the temperature of electrons is typically in the range of several 10,000 K while the gas remains typically in the range between room temperature and 1,000 K. The reason for this remarkable non-equilibrium is related to a rather low degree of ionization, typically 10^{-4} to 10^{-6}, in combination with a poor energy transfer efficiency between electrons and neutrals of typically 10^{-4}. Nevertheless, this small addition of hot charged particles changes the system properties fundamentally. It allows not only electrical conductivity but electrons can very efficiently excite atoms and molecules and by dissociation of molecules radicals are generated. In addition, close to the surface of electrodes, ions can be accelerated to very high energies up to the keV range. These unique properties lead not only to the characteristic bright emission from plasmas but they can drive a non-thermal chemistry which is impossible to realize otherwise. As a natural consequence, plasmas have found wide application in industry ranging from the fabrication of micro-electronic and micro–mechanic components, efficient light production in energy saving lamps to the generation or destruction of certain chemicals, treatment of textiles, and production of solar cells, to name only a few. In recent time even medical applications have become a very rapidly developing field. Due to the complexity and diversity of the systems, applications result often from an empirical or half-empirical approach. This result oriented development has been amazingly successful in the past. However, again for the same reason of complexity and seemingly huge number of free parameters a more systematic approach is clearly required in order to make further progress. The challenge is clearly in reduction of a system with an almost unlimited number of parameters to a few effective parameters which are traceable and allow a basic understanding of the main properties. Nowadays the combination of simplified models, advanced computer simulations, and detailed experimental diagnostics allows a remarkable advance in understanding of the fundamental properties. From this understanding new concepts and ideas can emanate and lead to better processes and products. In fact, this is an excellent example where fundamental science and applications are not in conflict but stimulate each other mutually.

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Materials challenges for magnetically confined fusion devices

C. García-Rosales

One of the main technical barriers towards the realization of a magnetically confined fusion power reactor is the development and qualification of materials able to fulfil the very demanding conditions imposed by the operation. Plasma facing components (divertor and first wall), including a plasma facing material and a structural material, are one of the most critical issues to be addressed by the fusion community. Plasma facing materials will be subject to high heat and particle flux leading to high temperatures, erosion by sputtering, hydrogen trapping and dust production, in addition to off-normal events (disruptions, ELMs) and high levels of neutron irradiation. For structural materials, neutron irradiation will result in severe radiation damage with a strong impact on their physical and mechanical properties. Another very critical material issue is related to the insulating components used in a number of key systems for diagnostics, plasma heating and current drive, and remote handling, which will be also exposed to high neutron and gamma fluxes, resulting in degradation of important physical properties like electrical resistivity, optical absorption and radioluminescence.

In this presentation the most challenging material issues to be faced with magnetically confined fusion devices will be discussed, focusing mainly on the plasma facing components and in particular on the divertor. Critical material and physics aspects will be highlighted while evaluating the technological differences between near-term (ITER) and long-term concepts, and the ways to bridge them.

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Low Temperature Plasmas and Applications

F. J. Gordillo-Vázquez

Low Temperature (non-fusion) Plasmas have become an unavoidable tool in modern technology, with well established applications that range from micro and nanoelectronics to coatings and from waste and exhaust treatment to new lighting sources. In addition, low temperature plasmas are finding new emerging uses in a variety of novel medical applications and in aeronautics (plasma flow control), propulsion (new plasma based engine concepts), and plasma-assisted combustion as well as, among many other applications, in the electromagnetic manipulation of the plasma formed during re-entry flights of space vehicles. Most of these applications are ultimately based in the unique properties of low temperature plasmas and, more specifically, in their non-thermal equilibrium nature that allows achieving independent control of the energy of, on the one side, the ionic and neutral species and, on the other, of the free plasma electrons. However, a distinct feature of low temperature plasmas is, contrarily to fusion plasmas, the relatively low temperature of heavy (neutrals and ions) species (usually around 300 degrees kelvin or room temperature) and the high electron mean energy that can reach up to 10 electron volts (more than 100000 degrees kelvin). This pronounced difference between heavy and electron mean energies is key to initiate many chemical reactions that will not be possible (or would proceed very inefficiently) with purely thermal sources as, for instance, conventional ovens. In this seminar we will initially talk about the fundamentals of low temperature plasmas to continue with a review of their applications with an emphasis on the nascent investigations of emerging technological applications of low temperature plasmas.

Aplicaciones de Plasmas de Baja Temperatura

Los Plasmas de Baja Temperatura (no de fusión) se han convertido en una herramienta imprescindible de la tecnología moderna con multitud de aplicaciones que incluyen la micro y nanoelectrónica, la tecnología de recubrimientos, el tratamiento de residuos y gases tóxicos así como el desarrollo de nuevas fuentes de luz basadas en plasmas. Además, los plasmas de baja temperatura están encontrando aplicaciones y usos en nuevas y variadas aplicaciones médicas, en aeronáutica (control de flujo por plasma), propulsión (nuevos conceptos de motores basados en el uso de plasmas), combustión asistida por plasma así como, entre otras muchas aplicaciones, en el estudio de la manipulación electromagnética del plasma formado durante la re-entrada de vehículos espaciales. La mayor parte de estas aplicaciones se basan en propiedades únicas de los plasmas de baja temperatura y, en particular, en su alejamiento del equilibrio térmico, lo cual permite controlar de manera independiente la energía de, por un lado, las especies neutras e iónicas y, por otro, la de los electrones libres del plasma. Sin embargo, un rasgo distintivo de los plasmas de baja temperatura es, a diferencia de lo que sucede en plasmas de fusión, la baja temperatura (alrededor de 300 grados kelvin o temperatura ambiente) de las especies pesadas (neutros e iones) del plasma y la elevada energía media electrónica que puede alcanzar hasta los 10 electrón-voltio (más de 100000 grados kelvin). Esta gran diferencia entre las energías medias de especies pesadas y ligeras (electrones) es clave para que puedan tener lugar una serie de reacciones químicas que no serían posible (o serían muy ineficientes) con procesos puramente térmicos como los que tienen lugar en, por ejemplo, los hornos convencionales. En esta charla comenzaremos hablando brevemente de los fundamentos de los plasmas de baja temperatura para, a continuación, comentar sus aplicaciones haciendo especial hincapié en algunas investigaciones recientes sobre aplicaciones novedosas de los plasmas de baja temperatura.

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