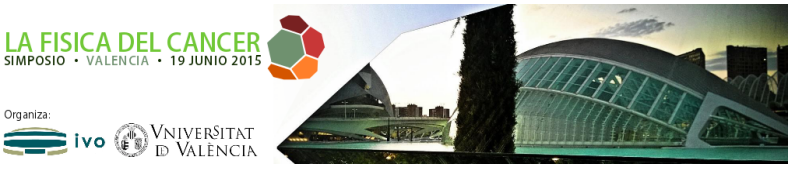
Simposio Física del Cáncer || Physics of Cancer Symposium



Friday, 19 June 2015 - Friday, 19 June 2015

Scientific Programme

You can download a PDF version of the programme **here**.

"IFIMED, The Facility of Medical Physics for Imaging and Accelerators"

José Bernabéu Alberola, PhD

Professor of Physics in the University of Valencia , Spain

<u>Abstract</u>: *IFIMED is a Facility for Research and Development of applications of the techniques of Particle and Nuclear Physics to the therapy and diagnostics of oncological and neuro-degenerative diseases. Such a facility has scientific equipment for research in components of particle accelerators, particle detectors and image science, as well as a small PET scanner for, among other topics, radiobiological studies. Its technological applications will imply the transfer of knowledge and innovation to the Spanish medical and industrial sectors.*

The Scientific-Technical and Economic Report of IFIMED was approved by CAIS, the Ministerial Committee for Singular Infrastructures, in 2010. It is supported by Agreement between the State Secretary of Research and the University of Valencia. Since 2007, IFIMED is a member of ENLIGHT, the European Platform of Particle Therapy Centers for research in Medical Physics, coordinated by CERN, the European Laboratory for Particle Physics. These research projects include at present ENVISION, the on-line monitoring of the application of hadrontherapy to patients, and the design of a protype for an ideal accelerator for Particle Therapy taking advantage of the Bragg Peak.

<u>About the speaker:</u> Jose Bernabeu was Staff Member of CERN, the European Laboratory of

Particle Physics, in the 70's and he is Professor of Physics in the University of Valencia since 1981. His research work has been mostly devoted to elementary particle physics, in the field of unified electroweak interactions within and beyond the standard theory. In recent times, he discussed the conceptual basis and methodology for a first observation of direct time reversal violation in the laws of physics. At present he works on physics in the LHC accelerator of CERN. He has published more than 200 research articles in the scientific journals of highest impact. Bernabeu has been Principal Investigator of Grants obtained by the Theory Group of Valencia and regularly invited to international Centres of excellence. He is a referee for journals, funding agencies and evaluation systems. He has been Advisor of more than 20 Ph. D. Thesis.

Academician of the National Academy of Exact, Physical and Natural Sciences of Argentina and of the Royal Academy of Sciences of Spain, he is and has been Chair/Member of Committees related to the scientific life in Spain, Europe and CERN. He is the Project Leader for the Facility of Research on Medical Physics: IFIMED. In 2001 he obtained the Distinction of the Valencian Generalitat to the Cultural Merit. The King Jaime I Prize in Basic Research was awarded to him in 2008.In 2011 he obtained the Medal of the Spanish Physical Society-BBVA

Foundation Prize.

"The heterogeneity of cancer diagnosis: interdisciplinary knowledge"

Estanislao Arana, MD, PhD

Radiology Department, Fundación IVO, Valencia, Spain

<u>Abstract:</u> *Cancer is a complex and heterogeneous disease from all viewpoints. Tumoral cells populations display remarkable variability in almost every discernable phenotypic trait, including clinically important phenotypes such as ability to metastatize and to survive therapy. Recent technological advances have improved the macroscopic and microscopic understanding of this problem. In this talk, we present a summary of imaging and diagnostic techniques to tackle this issue. There is a clear and present need of every scientist for involvement in a better knowledge of cancer heterogeneity. Quantification of lesion enhancement kinetics or textural heterogeneity is a promising approach towards better cancer diagnosis and evaluation of anticancer therapy. Their limits are thoroughly discussed and new lines are proposed.*

<u>References</u>:

Andrés Larroza, David Moratal, Alexandra Paredes-Sánchez, Emilio Soria, María L. Chust, Leoncio A. Arribas, Estanislao Arana. Support vector machine classification of brain metastasis and radiation necrosis based on texture analysis in MRI. J Magn Reson Imaging 2015 (in press)

<u>About the speaker</u>: Estanislao Arana is Consultant Radiologist at the Department of Radiology, Foundation IVO. He is also Thesis supervisor at "Master of Biomedical Engineering " at Polythechnic University of Valencia. He was a lecturer at the Catholic University of Valencia during the 2011-2014.Currently working on the application of advanced image posprocessing in clinical practice.

"*Phase Transitions in Oncology"*

Carlos Peña Garay, PhD

Research scientist, CSIC, Spain

<u>Abstract:</u> *Phase Transitions are a powerful and ubiquitous organizing principle within living cells. Phase transitions as mechanisms for organizing membranes, signal transduction networks, assembly of RNA and proteins or cell growth have been recently discussed in the literature. I will discuss the rules <span style="background-color:rgb(255, 255, 255);*

font-family:nimbus sans l,arial,helvetica,verdana,freesans,sans-serif">governing these phase transitions and show that a noise-induced phase transition is central in the route to disease.

<u>About the speaker</u>: *Carlos Peña Garay leads the theoretical research in solar neutrinos. Carlos participated in the resolution of the solar neutrino problem, difference between observed and standard solar model neutrino fluxes, what led to the discovery of neutrino masses and flavor mixing. In 1999, Carlos was the first to show that the correct solution to the solar neutrino problem was the one with large mixing named as the LMA solution. Since 2003, Carlos published influential works on solar neutrinos, a roadmad for future solar neutrino experiments and the relevance of the discovery of CNO cycle neutrinos. Nowadays, Carlos leads the most precise calculations of solar neutrino fluxes and works with the Borexino collaboration, which is leading the discovery of neutrinos produced by several nuclear reactions in the Sun.*

Carlos Peña Garay has produced the most precise calculations in cosmological simulations of dark matter and neutrinos. These calculations permitted Carlos to characterize in detail the shape of the neutrinos phase space distribution, with a density profile wit a core and a distorted Fermi Dirac distribution at low momenta. Most importantly, these simulations serve to predict cosmological observables sensitive to the neutrino mass. Lensing profiles of many galaxy clusters are among the best observables to verify the existence of the cosmological neutrino background and determine the neutrino masses.

Carlos Peña Garay has contributed in many areas in Astroparticle Physics and Cosmology, including neutrino oscillations, high energy neutrinos, neutrinoless doble beta decay, dark matter and modified gravity. In particular, Carlos is making pioneering proposals in searches of QCD axions and on the origin of low energy positrons observed in our galaxy by INTEGRAL and previous X-ray telescopes. Other contributions in science include a physical model of the human gut microbiota to describe the routes to disease.

“A physical approach to brain tumors using mathematics: Success stories"

Víctor M. Pérez García, PhD

Head of the Mathematics Dept., Universidad de Castilla-La Mancha, Spain

<u>Abstract:</u> *In this talk, I will discuss several examples of physics-like modeling in Oncology using mathematical models. The models are built to describe the known phenomenology and later used to propose novel hypothesis. I will describe the experimental verification of the proposals and how they have led to the development of clinical tools or novel therapeutical approaches to specific types of brain tumors.*

<u>About the speaker:</u> Graduate in Physics (Complutense U., 1991). PhD in Optics (Complutense U., 1995). Associate professor (1997) and full professor (2002) in Applied

Mathematics at the Mathematics Department of the University of Castilla-La Mancha. He has published more than 110 ISI-indexed research papers with 3400 citations and an H-index of 32. Currently working on the application of mathematical modeling to oncology and the implications in the clinic.

"Impacto de la innovación tecnológica en los resultados en salud frente al Cáncer"

Antonio Llombart Cussac, MD, PhD

Head of the Medical Oncology Dept., Hospital Arnau de Vilanova, Valencia, Spain

<u>Abstract:</u> *Not yet available*

<u>About the speaker:</u> Antonio Llombart, MD, PhD, is chairman of the Medical Oncology Service at the University Hospital Arnau de Vilanova in Valencia, Spain. He received his medical school training in Pamplona and Valencia, Spain; as well as his training in medical oncology at the University Clinic Hospital in Valencia. He performed a 4 years fellowship in the Breast Cancer Unit at Institute Gustave Roussy (Villejuif, France) focusing on new drugs (phase I and phase II studies). From 1997 to 2005, Dr Llombart was a member of the Department of Medical Oncology at the Instituto Valenciano de Oncologia. In 2003, he was promoted to the position of head of the Breast Cancer Research Unit. He obtained his PhD degree in breast cancer in 2005. From 2005 to 2010, Dr Llombart was the head of the Medical Oncology Service at the University Hospital HUAV in Lleida, Spain. In 2011 he returned to the Hospital Arnau de Vilanova in Valencia as Head of department of Medical Oncology and professor of Clinical Oncology at the Universidad Catolica de Valencia.

“On the law governing the lysis of solid tumors”

Miguel A. F. Sanjuán, PhD

Head of Dept. of Physics, Universidad Rey Juan Carlos, Madrid, Spain

<u>Abstract</u>: In this talk we present our work in Dynamics and Physics of Cancer [1,2,3]. In particular we will focus mainly in our work on in silico experiments and mathematical analyses supporting several hypotheses that explain the saturation expressed in the fractional cell kill law that governs the lysis of tumor cells by cytotoxic CD8+ T cells (CTLs). An hybrid cellular automaton model describing the spatio-temporal evolution of tumor growth and its interaction with the cell-mediated immune response is developed. The model parameters are adjusted to an ordinary

differential equation model, which has been previously validated [2] with in vivo experiments and chromium release assays. When the CTLs eradicate efficiently the tumor cells, the model predicts a correlation between the morphology of the tumors and the rate at which they are lysed. As the effectiveness of the effector cells is decreased, the saturation disappears in practice. This limit is thoroughly discussed and a generalized fractional cell kill is proposed. This is joint work with Alvaro G. López and Jesús M. Seoane.

<u>References</u>:

[1] Alvaro G. López, Jesús M. Seoane, and Miguel A.F. Sanjuán. On the law governing the lysis of solid tumors. Journal of The Royal Society Interface, 2015.

[2] Alvaro G. López, Jesús M. Seoane, and Miguel A.F. Sanjuán. A validated mathematical model of tumor growth including tumor-host interaction, cell-mediated immune response and chemotherapy. Bulletin of Mathematical Biology 76, 2884-2906, 2014.

[3] Alvaro G. López, Juan Sabuco, Jesús M. Seoane, Jorge Duarte, Cristina Januário, and Miguel A.F. Sanjuán. Avoiding healthy cells extinction in a cancer model. Journal of Theoretical Biology 349, 74-81, 2014.

<u>About the speaker:</u> Miguel A. F. Sanjuán is Professor of Physics at the Rey Juan Carlos University in Madrid. He is also the Head of the Department of Physics and the Head of the Research Group on Nonlinear Dynamics, Chaos Theory and Complex Systems. He was a lecturer at the University of Valladolid during the 1982–1984 period and later he became a Professor at the Polytechnic University of Madrid, 1986-1997. He is a foreign member of the Lithuanian Academy of Sciences. His active Spanish blog greatly helped common public to improve the basic understanding of chaos theory and complexity, and he has written some popular articles in Spanish newspapers.

"Applications of Particle Physics to treatment and monitoring in hadrontherapy"

Josep F. Oliver, PhD

Research scientist, CSIC, Spain

<u>Abstract</u>: *Hadrontherapy is a therapy modality based on irradiating tumors with beams of atomic nuclei. These nuclei are able to go through the tissues and deposit with high accuracy a high percentage of their energy in a small region, just before being stopped. This behavior allows a highly accurate delimitation of the zone to be irradiated. Hadrontherapy exploits several techniques related to particle physics. This talk illustrates some of these techniques by using the development of a Compton telescope for treatment monitoring that the IRIS group is currently building as a*

thread connecting the different stages involved in a treatment: from the treatment planning until the final treatment monitoring.

<u>About the speaker</u>: *Josep F. Oliver works at the Instituto de Física Corpuscular, IFIC (CSIC-UV). In 2004 he obtained a Ph.D. degree in Physics at the University of Valencia. From 2004 to 2006 he worked at the University Libre of Bruxelles (ULB). In 2006 he went to IFIC as a postdoctoral researcher. Currently he is with the Medical Physics group IRIS, where he is in charge of the image reconstruction research lines. He is also in charge of the image reconstruction subject in the Master of Advanced Physics. His research interests include reconstruction algorithms, hadrontherapy monitoring, physics models of the image formation processes in PET and Compton cameras as well as applications of high energy physics techniques to medical image reconstruction.*

"Advances in Accelerators for Hadrontherapy"

Silvia Verdú-Andrés, PhD

Brookhaven National Laboratory (Upton, NY, USA)

Abstract: *Hadron therapy uses external beams of hadrons for cancer treatment. This technique exploits the characteristic energy deposition curve of hadrons to deliver a large amount of therapeutical dose to tumoral sites for a reduced damage to surrounding tissues.*

Currently there are about 49 facilities in operation that deliver proton therapy and 8 facilities for carbon ion therapy. All those facilities use either cyclotrons or synchrotrons to deliver particle beams with the required energies to treat deep-seated tumours. The scientific community and industry are making considerable efforts to provide the next generation of accelerators for hadron therapy, with special focus on reducing its size and cost.

The talk will review the available accelerator technology for hadron therapy and the new accelerator concepts under development.

About the speaker: *Dr. Silvia Verdú-Andrés studied Physics in the University of Valencia and received her PhD in Physics from the same university in 2012 with a thesis on “High-gradient accelerating structures and their application in hadrontherapy”. This work was developed under the supervision of Prof. Ugo Amaldi (TERA Foundation, Italy) and Dr. Ángeles Faus-Golfe (IFIC, Spain) in the framework of the Marie Curie Training Network PARTNER. She currently works at Brookhaven National Laboratory (Upton, NY, USA) where she is dedicated to the development of Crab Cavities for the High Luminosity upgrade of the Large Hadron Collider LHC at CERN.*

"Living Tissue as Active Matter"

Ramin Golestanian, PhD

Professor of Theoretical Condensed Matter Physics, University of Oxford, UK

<u>Abstract:</u> A collection of cells that form a colony or a tissue makes a correlated physical system where individual components exhibit chemical and mechanical activity, undergo growth and death processes, and interact with each other via mechanical stresses and chemical signals. At a phenomenological level, such a system can be studied using the same type of formalisms that physicists use to study equilibrium phases of matter, such as gas, liquid, solid, ferromagnetic, and superconducting. If our description captures the key elements of the system, we should be able to use it to also study phase transitions between these phases. In my talk, I review the latest developments in constructing such phenomenological theories to describe living tissues, and present some recent results that help us predict onsets of sharp transitions that take the system away from homeostatic conditions. Our ultimate goal is to view cancer metastasis as such a transition, although we are still at the beginning of this type of investigation.

<u>About the speaker: </u>Prof. Golestanian is Professor of Theoretical Condensed Matter Physics at the University of Oxford. He received the Holweck Medal and Prize for his pioneering contributions to the development of the new research area of active soft matter, particularly microscopic swimmers and active colloids. His research aims to understand the physical and structural properties of both synthetic and biological soft matter.