Proposal for Distinguished lecturer: Jochen Wambach
Lecture: Matter under Extreme Conditions

Research Unit that proposes: CFTP
(The lecture is also part of the program of Colloquia of the Department of Physics)

Link to webpage with the announcement:
https://fenix.tecnico.ulisboa.pt/departamentos/df/coloquios-do-departamento

Venue and date: VA4 (Ed. Civil), November 15 2017

Short biographical note on the lecturer:
Born in Germany, Professor Jochen Wambach is Director of the European Centre for Theoretical studies in Nuclear Physics and related areas (ECT*) based in Trento. ECT* is registered as an European Research Infrastructure, and it is an institutional member of NuPECC, the Nuclear Physics European Collaboration Committee.

Professor Jochen Wambach, was previously full Professor Inst. Nucl. Phys., Techn. Univ. Darmstadt (since 1996), where he acted as Head of the Theory Group 'Hadrons and QCD'. He obtained his Ph.D from the University of Bonn in 1979, after which he became Research Associate at SUNY Stony Brook, Senior Researcher at Forschungszentrum Julich, and Deputy Director of Inst. Nucl. Phys., Forschungszentrum Julich.

Jochen Wambach, worked in a variety of problems in Nuclear and Hadron Physics, being author of more than 250 publications, including famous papers (with more than 250 citations). He is Fellow of the American Physical Society and Associate Editor of the European Journal of Physica A and Divisional Editor of Physical review Letters, having participated in a large variety of Advisory International Committees, in Europe and in the USA, including service at the Senat 'Deutsche Forschungsgemeinschaft' (DFG).

Why is the talk important?
The lecturer is the Director of ECT*. ECT* is a centre of competence that promotes coordination of European research efforts in nuclear physics and offers an advanced doctoral in Nuclear Physics in a broad sense - from low energy Nuclear Physics and Nuclear Structure, to Quantum Chromodynamics and Hadron Physics, Physics of Matter under Extreme Conditions and Ultra-Relativistic Heavy Ion Collisions and applications in Astrophysics.
At the moment at ECT* Jochen Wambach is developing a new method to calculate real time properties of strong-interaction matter at high temperatures and densities, with impact in solving problems in areas as Astrophysics and Particle Physics.

Summary of the talk:

For scientists in general

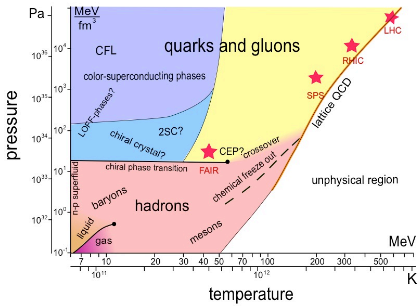
What happens ultimately to matter upon heating and compression? This question relates to cosmological settings in the early universe and the physics of neutron stars. I will give a brief historical review on matter under extreme conditions, starting from theoretical observations in the 1960s and the problem they posed for Big Bang cosmology. With the advent of Quantum Chromodynamics (QCD), in which it was realized that hadrons consist of quarks and gluons, the situation changed. The quark-gluon substructure opened the possibility for a transition to a new state of matter in which quarks and gluons become deconfined and can thus traverse large space-time distances. In theory, a rich phase diagram has emerged which has many similarities with other substances but also distinct differences. The quark-hadron transition can be explored in collisions of relativistic heavy ions. These experiments shed light on the generation of the visible mass in the universe.

Layperson summary

Relativity and quantum mechanics, and later Quantum Field Theory, unified our understanding of matter and light, particles and waves, as well as forces and matter. This new view of the universe is more than formal: it gave rise to a real technological revolution with substantial benefits for the society, from technological gadgets that have become part of our daily life, to biology and medicine. Electron microscopes and modern accelerators, where matter behaves like light, are used all over the world in a wide variety of applications, ranging from research in material sciences to new techniques for the diagnosis and treatment of diseases in medicine.

This lecture focuses on a family of particles called hadrons. The best known examples of hadrons are protons and neutrons, the particles that make all atomic nuclei, the core of matter. The atomic nuclei are also a prime example of matter under extreme conditions of unimaginably high density. While most of the visible matter in our Universe is contained in atomic nuclei in the form of protons and neutrons, many other hadrons are formed in cosmic rays and particle accelerators. They all consist of smaller constituents, usually two or three "quarks", held tightly together by other particles called "gluons" which transmit the strong interaction, the strongest of the four fundamental forces of nature. But a complete and detailed description of all hadrons in terms of quarks and gluons has not yet been achieved, and the microscopic composition of some hadrons is still under dispute. Recent experiments have found evidence for new multiquark states, and in the near future the search for hadrons with even more complicated structures, so-called exotic states, will intensify.

And what happens when one puts these hadrons in a very hot and/or dense environment? Only few established facts are available at present. The lecture will tell the story of what has been learned about the behaviour of matter in extreme conditions, as they were prevalent in the very early Universe, and still occur in some astrophysical objects such as neutron stars, or as they are created for very short periods of time in violent collisions of heavy ions in today's particle accelerators.



Information on Host Institution:
CFTP is a research unit of IST with the main mission of contributing decisively to the development of Theoretical Particle and Nuclear Physics and related areas. As a leading Portuguese research unit in Theoretical Particle, Hadron and Nuclear Physics, it comprises different groups specialized in Higgs Physics, Supersymmetry, Neutrino Physics and CP violation, and Hadron and Nuclear Physics.

CFTP policy is to further assert its position at the international level, by fostering a culture of excellence (CoE) in advanced training and scientific research, embedded into an international context. CFTP mission also includes the promotion of culture, science and technology for citizenship . The lecture fits well into the CFTP policy since

-It contributes to the training of young scientists and their knowledge on Hadron Physics, through its insertion into the Colloquia program of the Department of Physics; in addition and, importantly, the subject and methods to be addressed have applications and impact going beyond Hadron Physics.
-It contributes to new vistas for international collaborations: at present, a priority for the CFTP Hadron Physics group, led by Teresa Peña, is to cross the boundaries between groups working on electron scattering as at JLab-USA, with which collaborations exist, and groups working in Europe on dilepton production and electron-positron annihilations, as in heavy-ion and elementary hadron collisions at intermediate energies, as at GSI Darmstadt. The visit of Jochen Wambach is one of the steps in that direction.
-It contributes to the general public information on relevant questions in science nowadays.