De Oosterpoort, Groningen
Friday, 7 April 2017

Focus Session: Physics & Cosmology

Matter over antimatter: 50 years after Sakharov

Programme:

- Marco Drewes (Technical University of Munich): Matter and Antimatter in the Universe
- Jordy de Vries (Nikhef): Probing new sources of CP violation with lasers and colliders
- Paul de Jong (Nikhef, UvA): Cosmological implications of Higgs studies at the LHC
- Gerco Onderwater (RUG): Antimatter in the lab - what we know, and how we figured it out -

Session leaders: Rob Timmermans (RUG)

Abstracts:

Marco Drewes (Technical University of Munich): Matter and Antimatter in the Universe
The existence of antimatter has been theoretically predicted and experimentally confirmed many decades ago. Its properties have been studied in great detail in the laboratory, and nowadays antimatter is even used in medical imaging. In spite of this impressive progress, there are still deep mysteries associated with antimatter: Are there worlds that are composed of antimatter in our universe? Why were matter and antimatter produced in slightly different amounts in the big bang, so that some matter was left to form galaxies, stars and planets after the mutual annihilation of most particles and antiparticles? And how does this relate to particle physicists' ideas about the fundamental laws of nature? We give an overview of the present state of research on these questions, covering theoretical as well as observational aspects.

Jordy de Vries (Nikhef): Probing new sources of CP violation with lasers and colliders
The absence of anti-matter in our universe hints towards new sources of CP violation that are not present in the Standard Model. One possible source of such CP violation could hide in the interactions of the recently discovered Higgs boson. Footprints of Higgs CP violation can be found in a large variety of experiments at a wide range of energy scales. From low-energy molecular high-precision experiments, such as the recently started electric dipole moment experiment in Groningen, up to the high-energy frontier at the Large Hadron Collider. In this talk I will discuss how these different experiments complement each other in the search for Higgs CP violation.

Paul de Jong (Nikhef, UvA): Cosmological implications of Higgs studies at the LHC
Baryogenesis, or the creation of the matter-antimatter asymmetry in our universe, may be related to electroweak symmetry breaking, the phase transition in which the Higgs field in the vacuum obtained the non-zero value it has today. Five years after the discovery of the Higgs boson, the study of its properties at the LHC is really taking off at full speed. We will show the state-of-the-art of measurements related to the Higgs particle, and their implications on our understanding of cosmology. Many of these measurements are still limited by the low number of Higgs particles recorded, but we will outline the ambitious plans of the LHC accelerator and experiments upgrades.

Gerco Onderwater (RUG): Antimatter in the lab — what we know, and how we figured it out —
The theoretical prediction and experimental discovery of antimatter around the 1930's mark a turning point in the early days of particle physics. There are compelling theoretical reasons to believe that matter and antimatter have exactly the same properties (mass, lifetime), aside from having opposite signs on all "charges" (such as electric charge, flavour, spin). Since the 1930's in many experiments we have gleaned detailed knowledge about the actual similarities, and more interesting, the differences in the properties of matter and antimatter. An overview of the history and current state-of-the-art of the experimental efforts to understand the intricacies of matter and antimatter will be presented.