Kluyverprize 2021

Also this year the Nikhef theses and their summaries provided an inspiring cross section through the rich scientific programme of the institute. It was a great pleasure for the members of the jury to read, discuss and finally rank them.

A total of 22 theses covered topics in:

- the LHC programme, in particular the ATLAS, LHCb and Alice experiments;
- high energy theory;
- astroparticle physics;
- gravitational wave experiments and modelling;
- dark matter searches;
- neutrino oscillations;
- electron dipole moment measurements and
- detector R&D and construction.

The physics analyses of the LHC data - with the detectors after 10 years of successful operation ever better understood and with the analysis techniques reaching new levels of sophistication - now reveal rare decay channels of B mesons and upper limits for even rarer channels; they allow precision analyses of Z-decays (even superseding those at LEP); they allow the search for rare or forbidden Z-decays and other beyond the standard model phenomena. It is fascinating to see that the quality of the data is higher and that the analyses are more sophisticated and creative than could be dreamt of at the beginning of LHC operation. And it is exciting that there is more to come: with upgraded detectors and, in the future an upgraded LHC, this programme holds a large promise for the next break through after the Higgs discovery. As we all know, some tantalizing indications of phenomena beyond the standard model may already be present in the data. The quality of the analyses performed by the Nikhef PhD students guarantees that such phenomena will not escape observation!

Also other roads possibly leading to a domain beyond our present knowledge and understanding are vigorously explored in the Nikhef programme like searches for cosmic dark matter and more in general astroparticle physics, including observations of the most energetic cosmic rays and of neutrino oscillations. Exploratory as these studies may be, they all are ‘state of the art’ and they all will push back boundaries of our understanding of the universe.

The most spectacular breakthrough of the past five years was the observation and interpretation of gravitational waves. An experimental achievement that is almost incredible, but true! The Nikhef Ph.D. students are active over the full range of gravitational-wave experiments: understanding the data, interpreting them and predicting signals due to specific events. They are also concerned with increasing the detector sensitivity by suppressing noise in present-day and in future detectors. Suppression of noise can be achieved by damping the movements of the mirrors in the laser interferometers through highly sophisticated suspension structures, by active feed-back and by selecting a site for these interferometers that is as quiet and predictable as possible in terms of its geological structure.

A comprehensive discussion of the challenges and the technologies to overcome them in present-day and future gravitational-wave interferometers, including the modelling of geological ‘irreducible’ noise was provided in the summary of one of the theses. The title of that thesis is ‘Seismic and Newtonian noise modelling for Advanced Virgo and Einstein Telescope’. The author is Maria Bader. She is the winner of this year’s Kluyverprize!