Contribution ID: **15** Type: **not specified**

Neutrino Physics and Detectors

Thursday, 22 October 2015 09:00 (1 hour)

The study of the neutrino is the study of physics beyond the Standard Model. We now know that the neutrinos have mass and that neutrino mixing occurs causing neutrino flavour to oscillate as neutrinos propagate through space and time. Further, some measurements can be interpreted as hints for new particles known as sterile neutrinos. The measured values of the mixing parameters make it possible that the matter-antimatter (CP) symmetry may be violated through the mixing process. The consequences of observing CP-invariance violation in neutrinos would be profound. To discover CP-invariance violation will require measurements of exquisite precision.
After a brief historical introduction I will give an overview of the phenomenology of neutrino oscillations and summarise our present understanding of the phenomenon. The race is on to determine the neutrino mass hierarchy, to find evidence for CP-invariance violation and to understand whether there are undiscovered neutrino species, or forces, beyond those of the Standard Model. I will describe the experimental programme that is underway and that which is planned. To understand the physics that gives rise to the neutrino's unique properties requires measurements of exquisite precision. I will describe the novel detectors that are being developed and the developments in accelerator technique that are required to allow an understanding of the neutrino—and of the physics of flavour—to be developed.

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