CEA-Direction des Sciences de la Matière

Institut de Physique Théorique

Unité de recherche associée au CNRS

Cours de Physique Théorique de l'IPhT, année 2012-2013

Organisé en collaboration avec

Ecole Doctorale de Physique de la Région Parisienne - ED 107

The Physics of Neutrinos

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Les vendredis 11/1/2013, 18/1, 25/1, 1/2 à 10h00.

In the last 15 years neutrino physics has undergone a radical change related to the fact that for neutrinos the weak eigenstates are different from the mass eigenstates. This course aims to explain how this came to be and to discuss some of the various important theoretical consequences of this discovery. The tentative plan is as follows:

1. Panorama of Experiments. In the first lecture we will briefly discuss the history of neutrinos, their experimental discovery, the quest for neutrino flavor oscillations and the experiments that finally established them. In particular, we will describe atmospheric, solar, reactor and accelerator oscillation neutrino experiments and what we have learned from them. We will also address non-oscillation terrestrial neutrino experiments that try to measure the absolute neutrino mass and to show whether neutrinos are Dirac or Majorana fermions.

2. Neutrino Oscillations. In the second lecture we will construct the simplest theoretical framework, the so-called standard three neutrino paradigm, that enables one to understand the results of the neutrino oscillation experiments. We will discuss neutrino oscillations in vacuum and in matter. In view of this theoretical framework we will revisit the experimental results and discuss the status today of the standard paradigm. We will consider simple extensions of the three neutrino picture that can be evoked to explain some of the “anomalies” in neutrino data.

3. Models for Neutrino Masses. In the third lecture we will address the seesaw mechanism, a way to understand the smallness of neutrino masses. We will talk about type I, II and III seesaw mechanisms and if and how one can experimentally test them. In general, seesaw models lead to new physics at very high scales. We will also address theoretical scenarios where the new physics scale can be much lower, at perhaps the reach of the LHC.

4. Neutrinos in Cosmology. The last lecture will be devoted to discuss some aspects of neutrinos related to cosmology. We will focus here on leptogenesis as the origin of matter-antimatter asymmetry. We may discuss some scenarios where neutrinos can also be connected to dark matter.

***Lieu** : IPhT, CEA Saclay, Orme des Merisiers, Bât. 774, p.1A Salle C. Itzykson.*
***Accès** : Par lignes de bus publics (269.02 et 91.06).*
Renseignements** : **http://ipht.cea.fr** ou **ipht-lectures@cea.fr

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