“Weak interaction in nuclei and Astrophysics: Standard Model and Beyond”

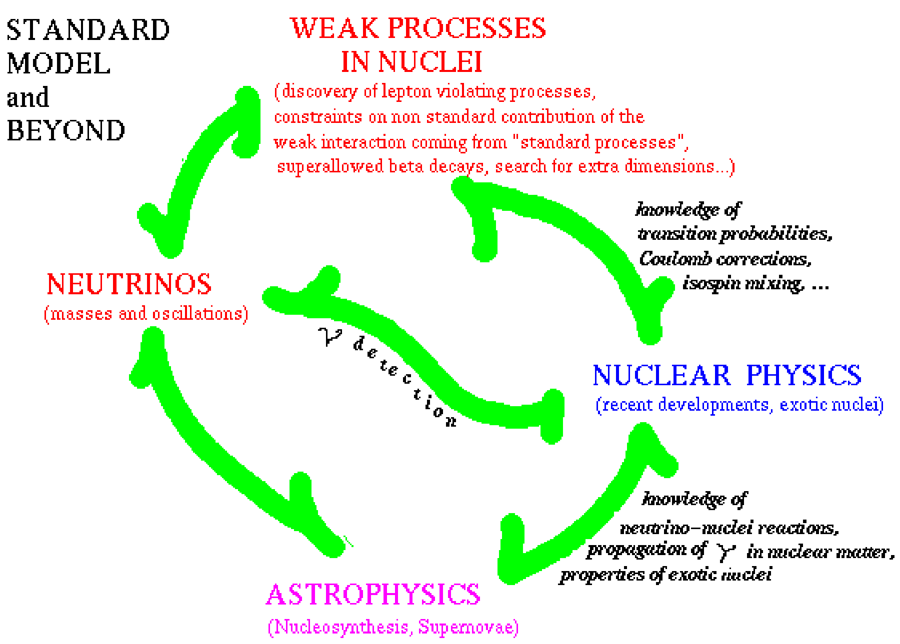
The experimental and theoretical discoveries in weak interactions of mesons and nuclei have been milestones for the developments of the $SU(3) \times SU(2) \times U(1)$ Standard Model. The Standard Model is now confirmed with a high precision. Neverthless, it still contains conceptual problems like the hierarchy problem and requires a number of input parameters.

At the present time there is no convincing experimental evidence fo the necessity of going beyond the standard model with one exception: The recent discovery of neutrino oscillations. This discovery has considerable impact on different domains of physics: - in astrophysics, on the comprehension of astrophysical phenomena (nucleosynthesis, supernovae explosion), both for the modelling of processes in stars and for the terrestrial detection of neutrinos emitted by stars (sun, supernovae); - in high energy physics, where we need to extend the Standard Model to describe non-zero neutrino masses and mixings; - in cosmology, in the search for dark matter.

The study of weak processes in nuclei contribute significantly to the search for physics beyond the Standard Model in several ways. First, with the search for processes which are not allowed in the Standard Model. Muon-electron conversion and neutrinoless double beta decay are examples of this type. Second, with the study of “standard” processes to give constraints on non-standard components of the weak interaction, such as beta decay of polarized and unpolarized nuclei or muon capture. Third, in the study of reactions induced by neutrinos on nuclei. They are necessary to interpret current experiments on neutrinos or to evaluate the feasibility of new projects. They are also of direct astrophysical interest, for the understanding of nucleosynthesis and supernovae explosion. Finally, the study of weak processes in nuclei offers possibilities for more “exotic” searches, such as the search of supersymmetric particles or the effects of extra dimensions.

In the near future, experiments on neutrinos and weak processes in nuclei will aim at challenging sensitivities and projects under study for the long term, if approved, will achieve outstanding ones. Nuclear structure transition probabilities are crucial in the interpretation of many of these experiments. These calculations often present disagreements that need to be better understood. For example, the charged-current $\nu -^{12} C$ reaction, used in the recent LSND and KARMEN experiments on neutrino oscillations, has been extensively investigated because of discrepancies between experiment and theory (up to a factor of 4 !). Recent studies show that nuclear structure effects are at the origin of this disagreement. Another example is given by the $\nu -^{208} Pb$ reaction. Lead will be used in new projects, such as OMNIS and LAND, to detect neutrinos emitted in a supernova explosion. At the moment, there are no data on the reaction cross sections and the theoretical predictions present significant discrepancies that have to be understood. Finally, future experimental data on the 2ν double beta decay in various nuclei will reach error bars of 10% whereas the theoretical predictions on the transition probabilities still often differ by a factor 2.

The workshop aims to bringing together worldwide experts, experimentalists and



theoreticians, working on these topics at the interface of nuclear physics, high energy physics and astrophysics. The exciting experimental discoveries and future challenging developments require to increase the synergy between these scientific communities. Having this in mind, we plan to devote much time to informal discussions.

The central goals of the workshop are :

- to review the present experimental status and the plans for future developments (approved or under study) both in the field of neutrinos and of weak processes in nuclei;
- to describe current developments in building nuclear structure models and open problems concerning the nuclear transition probabilities;
- to discuss the impact on astrophysical processes (nucleosynthesis and supernovae explosion);
- to explore new possibilities for “exotic” searches.