Summary talk of the electron scattering section

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Considerations about the relationship between electron and neutrino scattering are presented.

All the *NuInt* workshops hosted a section dedicated to electron scattering. Despite the fact that electrons interact mainly via electromagnetic forces, while neutrinos only via the weak interaction, the hope is that the similarity of the two probes will allow us to transfer to neutrino scattering some of the information obtained with electrons.

In the *NuInt05* workshop the attention of the contributions of the electron scattering section has been concentrated upon nucleon form factors, and especially for strange costituents. I do not want to summarize the main results presented, since I think that this job is better done by the authors [1–3]. In this contribution I would rather like to present some considerations about how the relationships between electron and neutrino scattering have developed and also I would like to make some guess on how they could develop in the near future.

The *NuInt01* workshop was focused on the understanding of the neutrino properties. The attention to the interaction between neutrinos and nucleons, or nuclei, was of instrumental interest aiming to reduce the uncertainties in the neutrino detection. The electron scattering data were used to verify the validity of nucleon and nuclear models used to describe the neutrino interaction in the detectors.

Since this first workshop there have been relevant advances in understanding neutrino properties. Flavor oscillations in both atmospheric and solar neutrinos has been established with a large confidence level. As a consequence, and also as by-product, the scope of the neutrino physics has widened, and, beside the interest in studying even better the neutrino properties, the attention to the possibility of using neutrinos as an investigation tool has grown.

The interest in studying neutrinos not produced in the laboratory is mainly astrophysical [4], even though there are also proposals to use them for geophysics purposes [5]. The laboratory produced neutrinos can be used to study the structure of the nucleon and nuclei. Under this light electron and neutrino scattering data have the same dignity.

As a first example of that, I would like to quote the study of the strange content of the nucleon. In electron scattering this study is done by using polarized beams which allows one to detect the parity violating terms of the process. These experiments are as involved as modern neutrinos experiments, but in addition they contain a rather large theoretical uncertainty. This is due to the fact that the parity violating quantity measured in these experiments is related to the interference between the dominant electromagnetic current, which cannot measure the strangeness content in the nucleon, and the weak current [6]. From the theoretical point of view a nucleon form factor measurement done with neutrinos is cleaner, since it involves weak interactions only.

The second example I want to make is related to nuclear studies. Neutrinos induce charge-exchange excitations in the nucleus, these are excitation modes unaccessible to electrons. Of course, hadron probes can also induce these excitations, but they are affected by two problems. The first one is that the strong interaction with the nucleus is not as controlled as the electroweak interaction. The second one is that hadrons probe only the nuclear surface, while leptons are sensitive to the full nuclear volume. Furthermore, even in neutral current processes neutrinos excite the nucleus mainly with the axial-vector currents [7], while electrons with the static charge current. The novelties of the neutrino induced excitations will be extremely relevant for the nuclear structure studies. For example, they would allow us to test our understanding of the strong hamiltonian in the charge-exchange sector, dominated by the one-pion exchange term. Or, as another example, they could test our knowledge of the weak interaction in nuclei, so far tested only in the beta decay processes.

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