PROCEEDINGS OF SCIENCE

Convener report of the session on Neutrino Physics

Gianpaolo Bellini[1]
Universita' degli Studi and INFN Milano
Via G. Celoria, 16 - 20133, Italy
E-mail: gianpaolo.bellini@mi.infn.it

In the last two years several new experimental results have been obtained in the neutrino field. They concern mainly: neutrino oscillations, geo-neutrinos, dark matter. In this short summary of the talks presented at the neutrino session I am mentioning only the novel results, which give either a first confirmation or a possible change in the neutrino physics. For the description of the experiments and of their results see the talks of : P. Belli, E. Fernandez-Martinez, M. Messier, C. Pena-Garay, O. Smirnov, M. Wurm

The Xth Nicola Cabibbo International Conference on Heavy Quarks and Leptons,
Frascati (Rome), Italy
October 11-15, 2010

[1] speaker

PoS(HQL 2010)088

1. Neutrino oscillation

The neutrino oscillation is an area still far from a final settlement. New results have been obtained on solar neutrino and by long and short base line experiments.

In the field of the solar neutrinos new results have been and are being obtained especially by the Borexino experiment. The ^{7}Be flux has been measured (presently with a total error of 10%, but a new release is expected soon with a total error ≤ 5%), introducing new constraints also on the pp flux; in addition the ^{8}B flux has been measured by Borexino with neutrino threshold down to 3.2 MeV, and by SNO with a lower neutrino threshold at 4.9 MeV (Neutral Current interactions), 5.4 MeV (Charged Current) and 3.7 MeV (elastic scattering). Borexino is under way to obtain a first measurement of the pep flux.

Before Borexino the MSW-LMA oscillation model was confirmed only in the matter regime with the experimental data on the ^{8}B flux. The new measurement of the ^{7}Be flux has produced the validation of this model also in the vacuum regime; we are waiting for the new Borexino release in order to have a more refined confirmation. The two determinations reached by the same experiment of an experimental point in the vacuum (^{7}Be) and another one in the matter (^{8}B) regime allowed the first determination of the ratio between the vacuum and the matter ν_e survival probabilities.

The transition region between vacuum and matter oscillation regimes is very sensitive to the hypothesis of not standard neutrino interactions (NSI), which are now expected by several models. Measurements of the pep flux and of the ^{8}B flux with a threshold below 3 MeV could give an important insight on this hypothesis.

Borexino has measured also the day/night asymmetry in the ^{7}Be neutrino region, which turns out to be fully consistent with zero, as foreseen by the MSW-LMA model. This result rules out the NSI hypothesis based upon the Mass Varying Interactions.

In the field of the long base line experiments new results have been obtained by MINOS and Opera.

The disappearance MINOS experiment is showing a possible striking result: a different behavior in the oscillation phenomenology by ν_μs and $\bar{\nu}_\mu$s. The best fit values of the two oscillation parameters for ν_μ and $\bar{\nu}_\mu$ show a difference, which in the case of the masses squared is about 2σ. Presently this evidence is weak, but if this difference will be confirmed in the future, a possible explanation of these results could be just the NSI, while a possible CPT violation seems less probable.

Another new result in this field has been obtained by the appearance experiment OPERA, which has found an event which can be interpreted as produced by a ν_τ with 2.01σ significance. If other candidates with a good significance will be found, this experiment will confirm with an appearance evidence what observed by Superkamiokande on the atmospheric neutrinos.

Finally I would like to recall the results of the appearance experiment MiniBooNE. They find an excess of $\bar{\nu}_e$ in the runs with an incident $\bar{\nu}_\mu$ flux, while no signal is observed in $\nu_\mu \to \nu_e$ transition. The signal found in the $\bar{\nu}_\mu \to \bar{\nu}_e$ transition is compatible with the one observed by the LSND experiment, for which E/L was very similar to the MiniBooNE one. Taking into account also the constraints imposed by the data of the KARMEN experiment, which did not observe any transitions, and by considering the simplest case of an effective two neutrino-like oscillation, the oscillation parameters have been found to lie within $2\cdot 10^{-3} < \sin^2 2\theta < 5\cdot 10^{-2}$ and $0.2 < \Delta m^2 < 2.\ eV^2$. This would mean a third oscillation region in the parameter space, in addition to what found in the solar and atmospheric neutrino sectors.

The possible third oscillation parameter region needs, in the present oscillation model, a fourth neutrino (sterile neutrino?). But this MiniBooNE result has to be confirmed (now it is only at 2σ level) and many aspects have to be clarified from the experimental point of view.

2. Geo-neutrinos

The radioactive decays of the ^{238}U and ^{232}Th chains, and of ^{40}K are a source for the Earth heat. The geological methods give the concentration of radioactive material in the terrestrial Crust, but only indirect indications exist for the Mantle (while for chemical reasons the presence of radioactivity in the Core seems unlike). The only way to measure the fraction of terrestrial heat produced by the radioactive decays present in the Earth interior is to measure the $\bar{\nu}_e$ emitted by them. After two hints provided by Kamland in 2005 and 2008, the second observed at 2.7σ C.L., in 2010 Borexino obtained the first real observation of geo-neutrinos at 99.997% C.L. (4.2 σ) . In Borexino the signal/noise ration is 2.5/1.

At Neutrino and NOW 2010 Kamland has shown a new evidence for the geo-neutrino observation similar to the one obtained by Borexino, with a signal/noise equal to 1/15.

While the evidence of geo-neutrinos is now very robust, the statistics accumulated is still not enough to discriminate among the various geological models and then to provide the fraction of terrestrial heat produced by the radioactive decays. We have to wait for this a couple of years.

3. Dark matter

Also in the Dark Matter sector there are important news.

Dama is confirming the observation of the annual modulation in 2-6 keV range. They reached a total exposure of 1.17 $ton\cdot year$, putting together the DAMA (7 years) and DAMA/LIBRA (6 years) data. The data favor the presence of a modulated behavior with the features for D.M. particles in the galactic halo at about 9σ C.L..

But now positive recoil-like excesses are observed by CRESST and CoGeNT.

CRESST, after the subtraction of noise events, find 23.2 events in an exposure of ≈ 500 $kg\cdot day$ ($CaWO_4$ crystals); this excess is confirmed at 2.6σ C.L.. While a D.M. inelastic scenario seems excluded by the CRESST data, these results could be interpreted in a low-mass WIMP scenario, compatible with the DAMA results. The CRESST collaboration planes to wait for further runs before claiming any interpretation based upon D.M..

In the meantime the CoGeNT experiment (ultra low noise Germanium detector) reported events in excess of the expected background in the low energy spectrum. Even if it is still early days (the possible contribution of background to this signal is excluded only at about 2σ level), this result can be interpreted in the frame of a D.M. model dependent scenario, confirming the DAMA signal.

Of course we have to wait for a possible confirmation of these two hints.